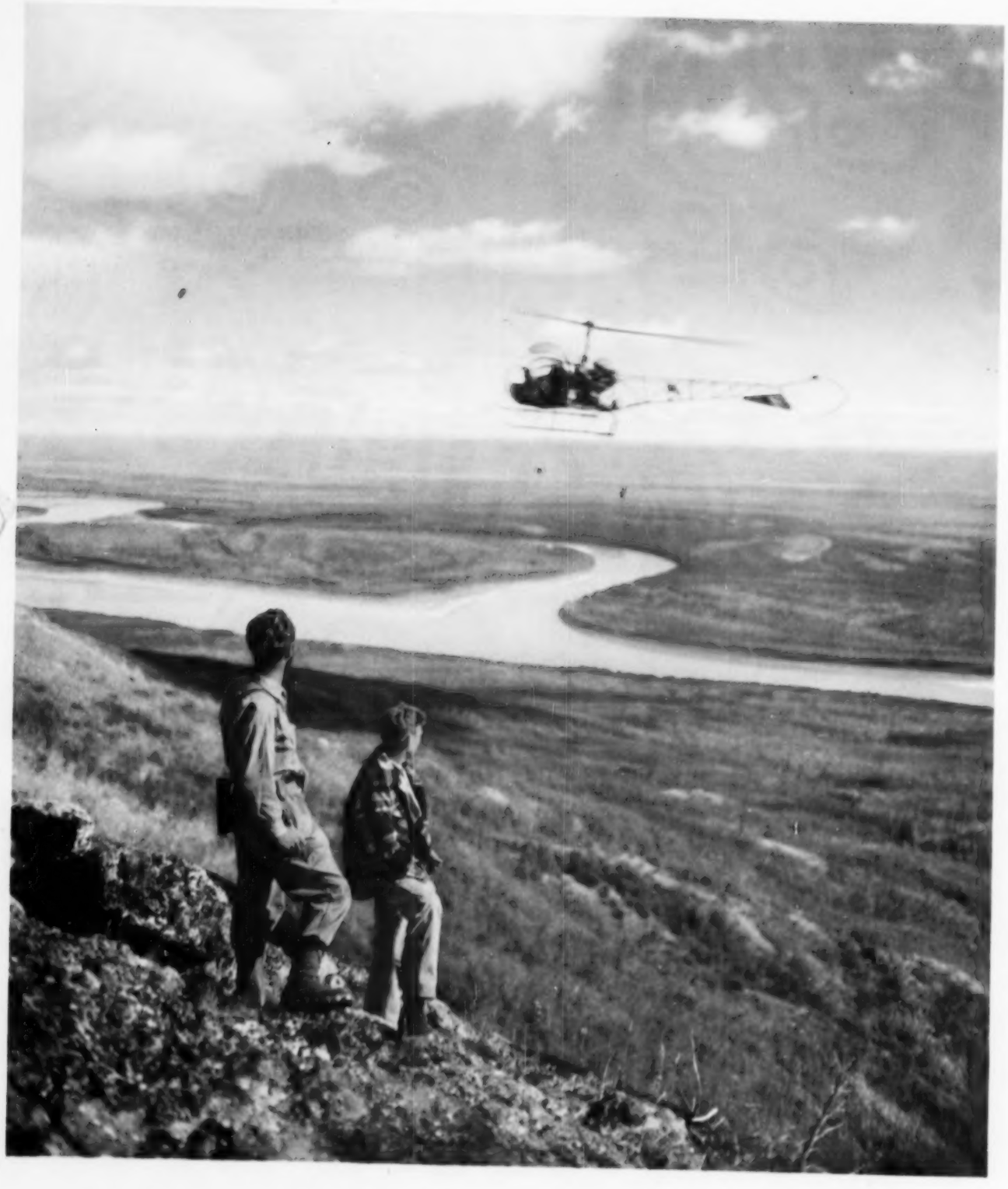

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MARCH 1955

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IS WITHIN YOUR GRASP

Blending with Warren NATURAL GASOLINE will give it the RETAINED VOLATILITY so necessary for superior performance after it reaches the fuel tanks of your customers.

Warren's production, transportation and storage facilities are your assurance of the quality and quantity of NATURAL GASOLINE you need . . . when and where you want it.

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EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARRENGAS, HOUSTON, TEXAS, SAN PEDRO, CALIF.

Atomic Camera

Activated by neutron-bombarded isotopes such as cobalt, iridium and cesium, this powerful and portable "atomic camera" was developed by The M. W. Kellogg Company for rapid and accurate inspection of welding seams at construction sites and in fabricators' shops.

The intensity and magnitude of the gamma rays emitted from the isotopes in this device make it possible to photograph many feet of welded seam up to six inches thick in a single short exposure. By comparison, to perform the same test with traditional X-ray equipment would take days and entail hundreds of exposures.

The M. W. Kellogg Company was the first firm specializing in the engineering and construction of petroleum refineries and petrochemical plants to be permitted by the AEC to use isotopes of this magnitude. Also the first in these specific fields to be authorized by the AEC to establish an internal training program for handling radioactive materials, M. W. Kellogg is well qualified to work with you on your construction engineering problems.

M.W. Kellogg

ENGINEERING FOR TOMORROW

THE M. W. KELLOGG COMPANY, NEW YORK 7, N. Y.

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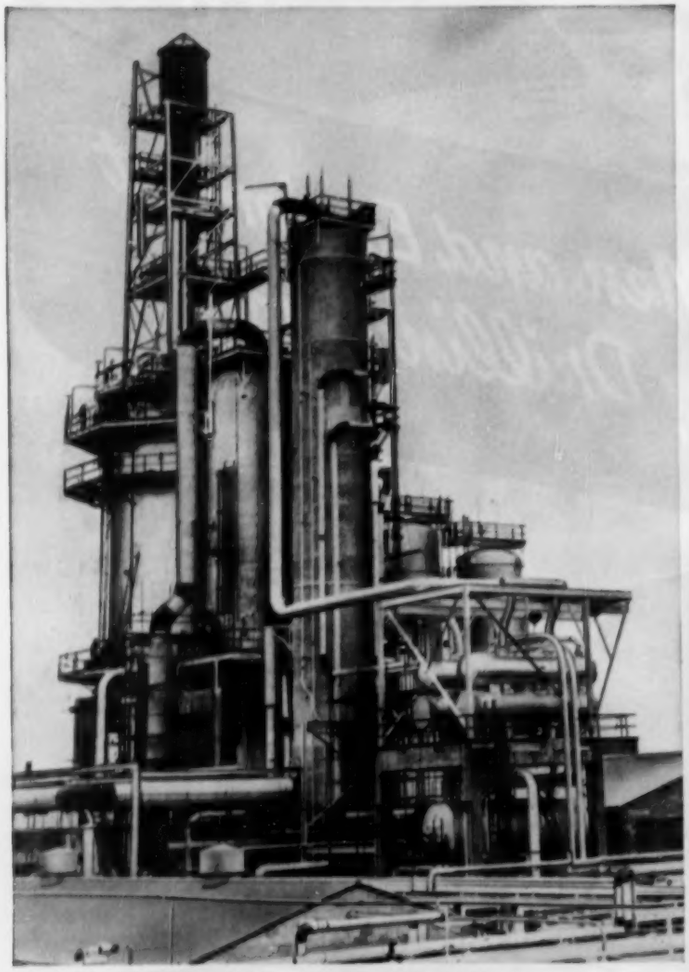
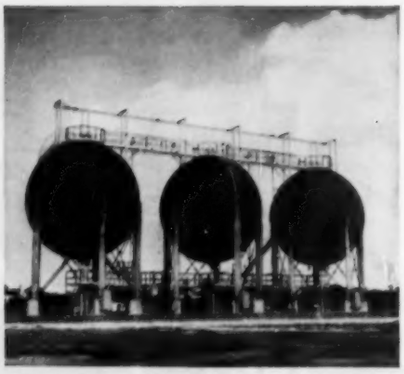


Continuing to serve America's refineries, GRAVER constructed the huge fractionator tower shown in the foreground for the new Mandan refinery of Standard Oil of Indiana. Reaching 120 ft. into the sky, it evidences the craftsmanship and experienced ability typical of Graver work.



GRAVERSPHERES are finding greater use than ever before with the tremendous growth of the refining and petrochemical industries. Ideally suited for high-pressure storage, they conform to Graver's exacting standards and are available in capacities ranging from 500 to 20,000 bbl.

Refiners depend on Graver for steel and alloy towers, pressure vessels and processing equipment. The large absorber tower shown above is Hastelloy-lined to protect against corrosion.

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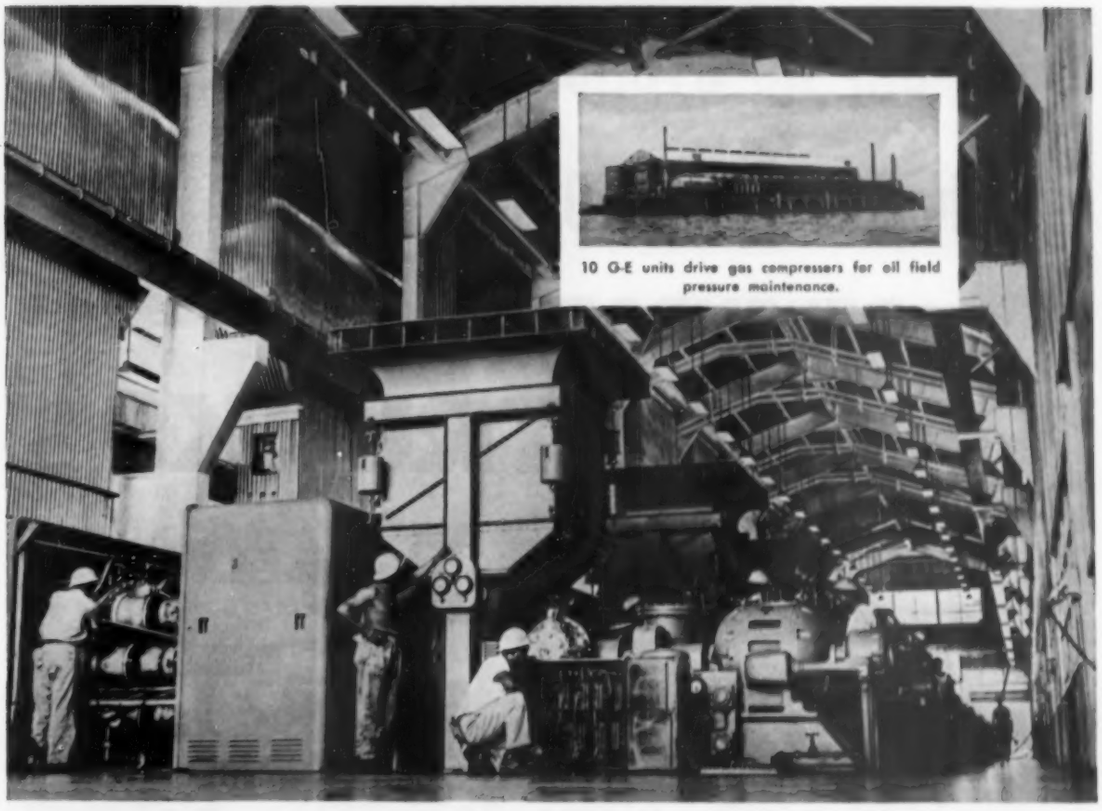
G.E. Reports on Electrical Developments...No. 10



10 G-E units drive gas compressors for oil field pressure maintenance.

CREOLE PETROLEUM PLACES WORLD'S LARGEST GAS TURBINE INSTALLATION INTO CONTINUOUS SERVICE IN VENEZUELA

THE LARGEST CONCENTRATION of gas turbine horsepower in the world is operating on a platform over Lake Maracaibo in Venezuela. There, seven miles from shore, ten General Electric gas turbines do a vital job for the Creole Petroleum Corporation: driving centrifugal compressors which maintain gas pressure and thereby increase the yield from the oil fields below.

SUCCESSFUL NEW CONCEPT: Creole's installation represents a new concept in oil field pressure maintenance. The combination of centrifugal compressors and combustion gas turbines is designed to return over 137,000,000 cubic feet of gas per day to the field at a pressure of 1,935 pounds per square inch.

Naturally, reliability was an important reason for the selection of G-E gas turbines. In addition, their light weight simplified the construction of the platform and its pilings. This remarkable installation is an outstanding example of petroleum industry enterprise and a milestone in the progress of the gas turbine.

KNOW-HOW WORKS FOR YOU: The G-E gas turbine can save money in almost all basic industries. Discuss your requirements with the G-E representative nearest you. *International General Electric Co., Industrial Sales, 570 Lexington Ave., New York 22, N.Y., U.S.A.* 1A-66-48

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Report on road behavior of many American premium gasolines is available in this Ethyl study.

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Refinery technology report shows ratings of premium fuels in 8 representative cars

In this 100-page booklet you will find 144 charts and graphs and 77 pages of detailed analysis showing how the nation's premium gasolines perform on the road.

This booklet is the latest addition to Ethyl's continuous study of the road behavior of gasoline designed to help you in the evaluation of your gasoline. In order to give you a cross section of the nation's premium-gasoline qualities, we periodically run a large survey in which we investigate the antiknock characteristics of base stocks for premium fuels.

In this survey, more than 60 gasoline samples were tested, representing 70% of the base stocks of the premium gasolines sold in the United States. More than 1,000 chassis dynamometer tests were made on eight different cars in Ethyl's unique controlled-weather rooms. In addition, more than 15,000 octane ratings and other tests were made in the laboratory.

The type of experience we have gained in preparing this report is but one of the tools our refinery technologists have to assist you in improving the road behavior of your own gasolines.

If you would like a copy of "Road Behavior of Commercial Premium Fuels—1954," see your Ethyl representative. He'll be glad to see that you receive a personal copy.

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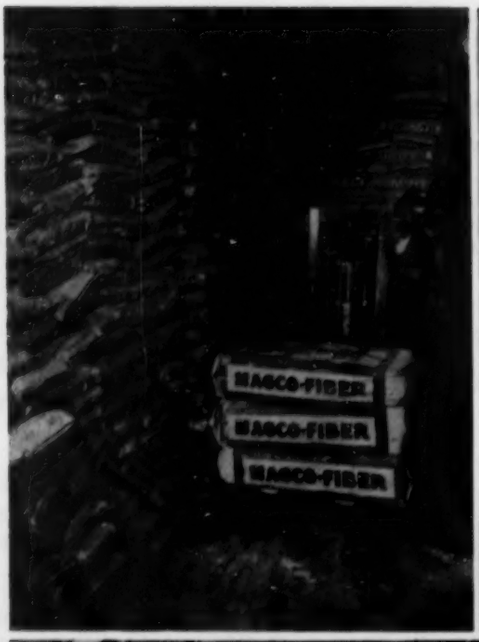

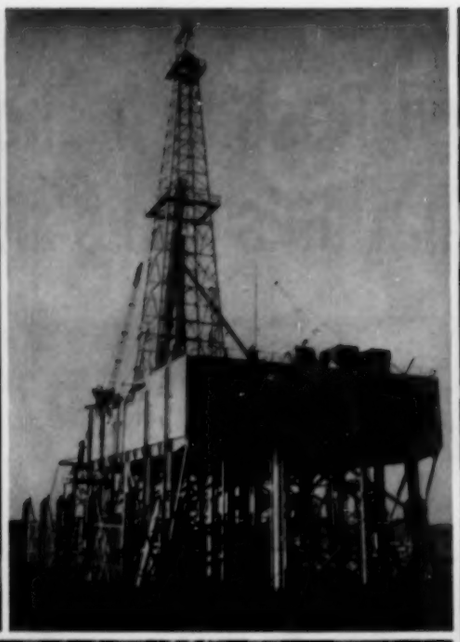

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Pacific Pumps inc.

PACIFIC PUMPS, INC., Huntington Park, Calif. — Centrifugal pumps for refineries, power stations, pipelines, and chemical plants; plunger pumps for oilwells.

the rig that's right for the job!

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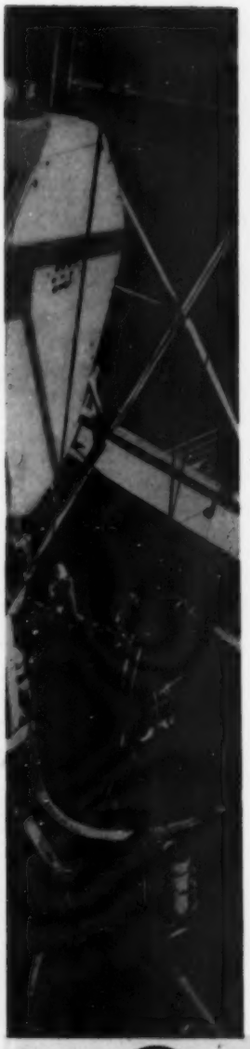
ONE OF THE DRESSER INDUSTRIES

Pioneer in developing dependable rotary drilling rigs, Ideco is guided by your needs in building the industry's "most-wanted" drilling equipment. Ideco products include Hydrair rigs, power rigs, Single and Dual Rambler rigs, Drive-In Ramblers, Full-View masts, Kwik-Lift masts, Kwik-Lever-Lift masts, Full-Lever-Lift masts, Shorty blocks, Streamlined Swivels, Rotaries, Mud-Master and Flo-Master slush pumps, Air-Tite clutches, accessories and supplies. Since the founding of its Beaumont, Texas, plant in 1920, Ideco has set the pace in the drilling equipment industry. For more hole per dollar, drive *your* drill string with Ideco oil equipment.



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The Dresser *Plus+* goes to sea! Ideco drilling equipment and Magcobar drilling muds form a seaworthy duet on Kerr-McGee's big barge No. 44 off the coast of Louisiana. Ideco equipment on this seagoing rig includes Airflo 1350-S rig, Hydrair H-35-S rig, 400-ton Big Shorty block, 300-ton Streamlined swivel, Streamlined oil-bath rotary, two Clark-Ideco T-880 slush pumps, and driller's console. Also on "sea duty" on the Kermac rig are Magcobar specialized drilling muds, best suited for offshore drilling.

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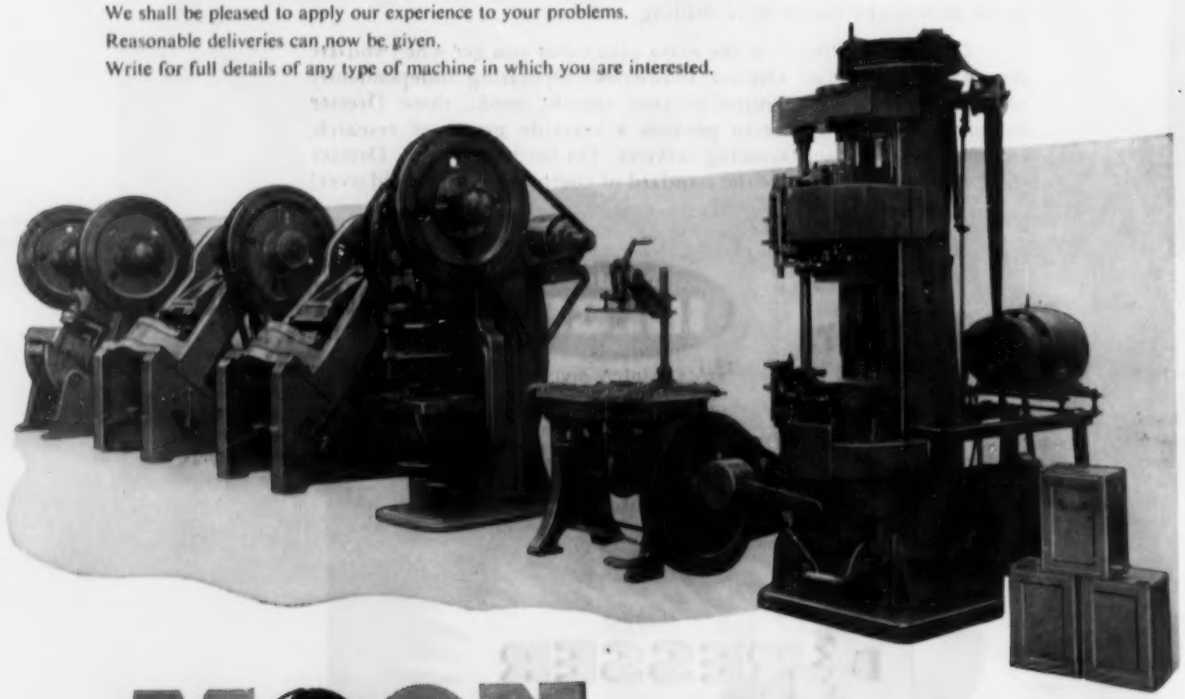

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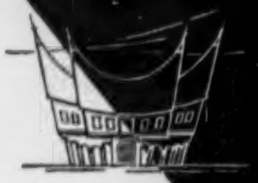
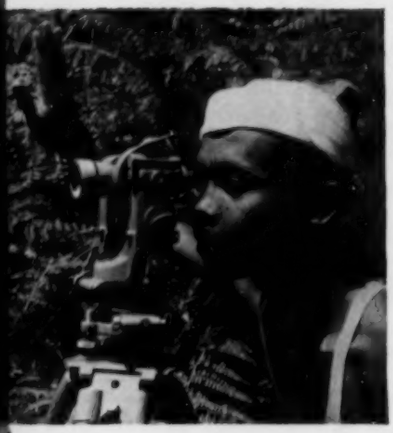
INDONESIA—Exploring and drilling for oil in the Minas field, Caltex employs mostly nationals, a Caltex policy in all lands. Men—like this surveyor's helper—are trained in the many skills required by the oil industry, all of which give higher income opportunities. The Republic of Indonesia benefits through development of its resources, producing new government revenues.





SOUTH AFRICA—Fabulous land of gold and diamonds, South Africa is experiencing vigorous growth and modernization. Here in the shadow of the famous "Table Mountain" is the warehouse area of the Caltex Cape Town terminal—storage place for the fine fuels and lubricants for increasing numbers of motorists who "Travel the Caltex Way."

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In 67 lands, across half the world, through such developments as these, Caltex is able to supply better fuels and lubricants for industry, for agriculture, and for motoring millions. These require a continual investment of funds and skills, backed by a faith in a better future for free nations.

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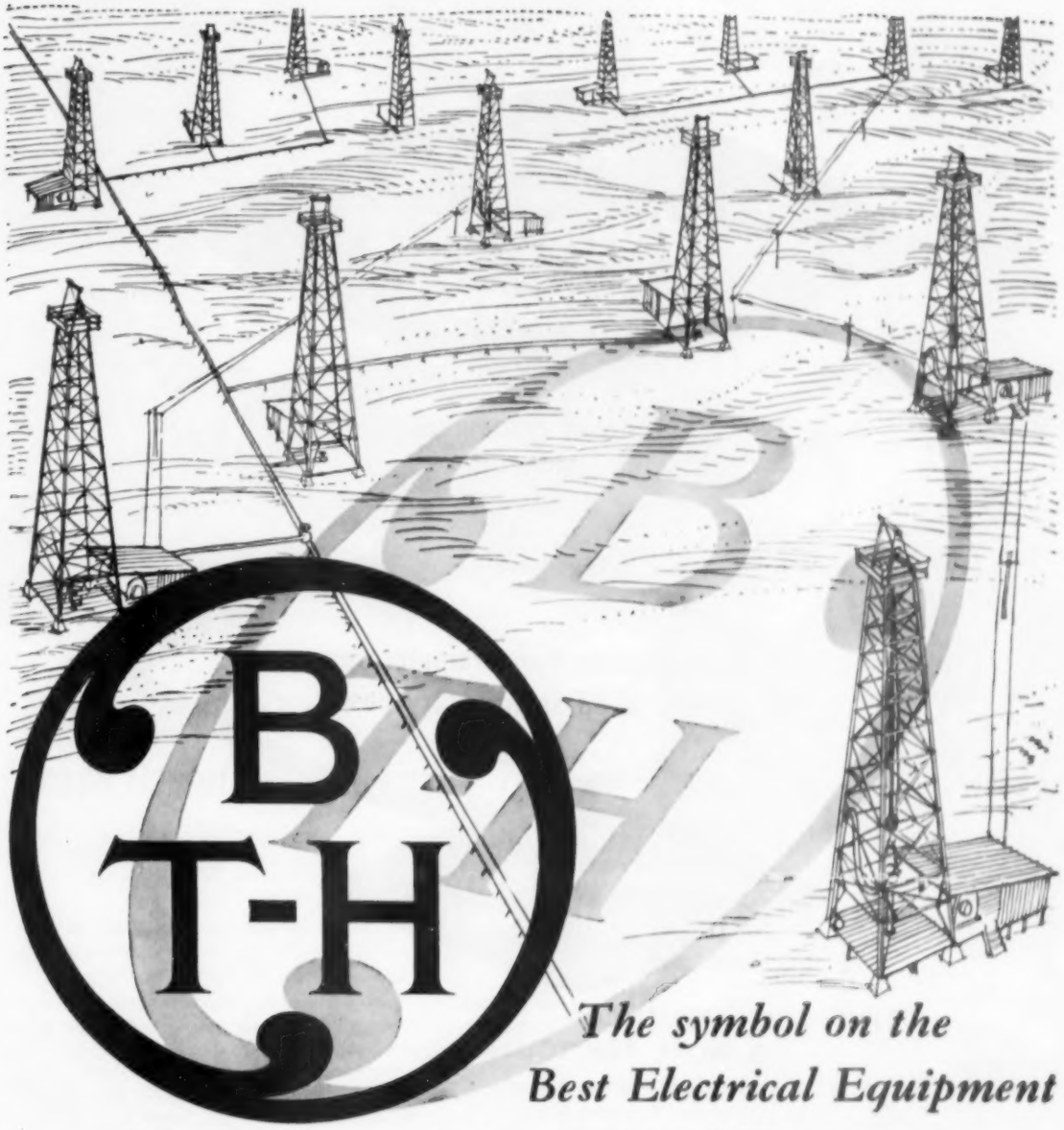

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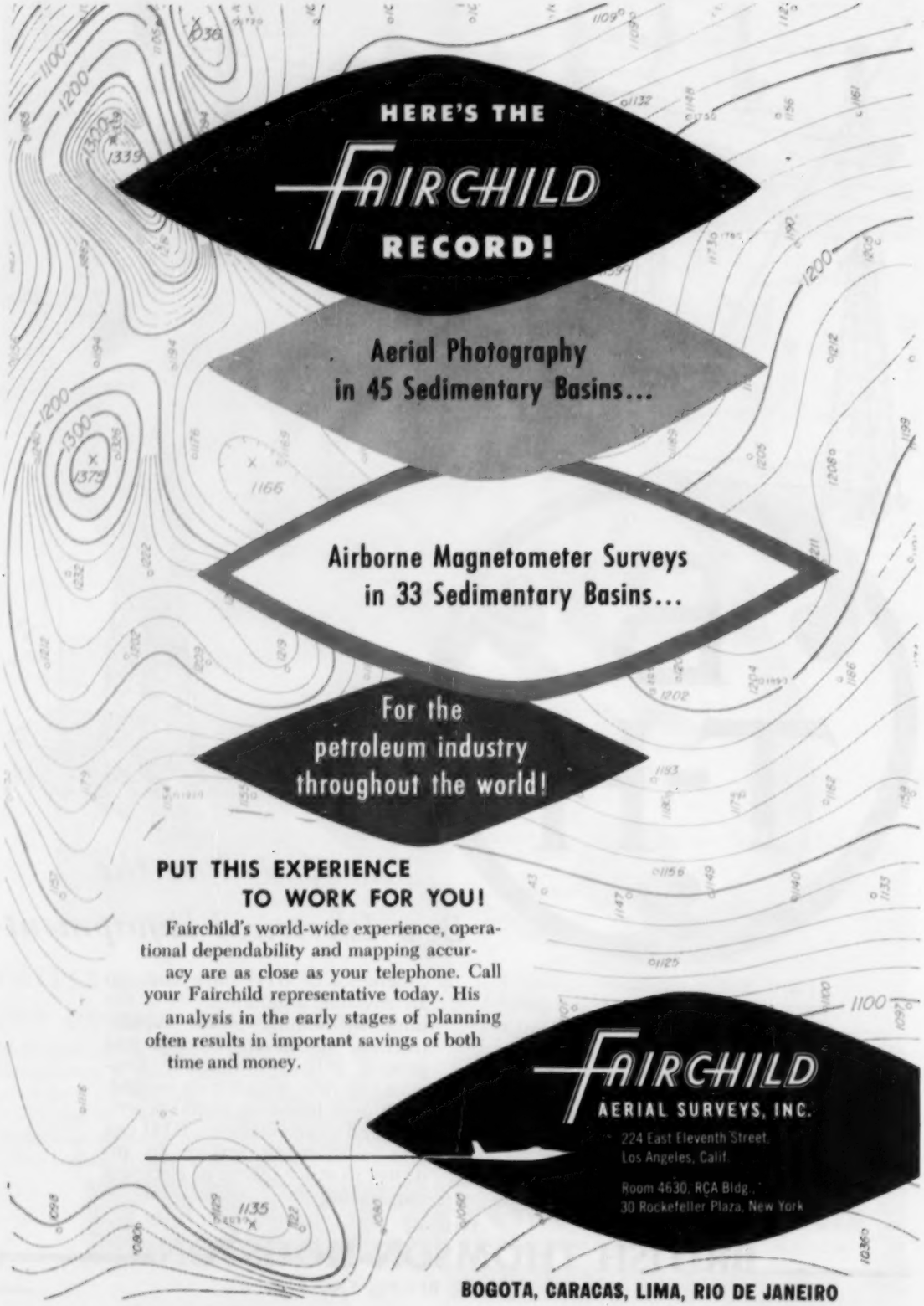
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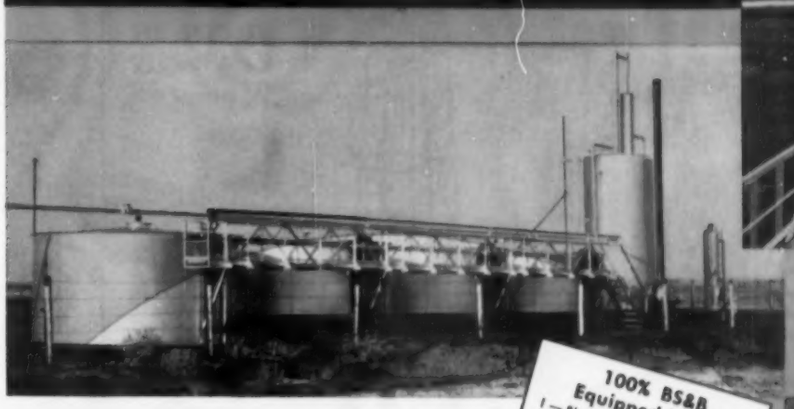

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As you travel through the oil country these days, you'll notice more and more producing leases which are 100% BS&B equipped. And for good reason!

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100% BS&B Equipped Lease:
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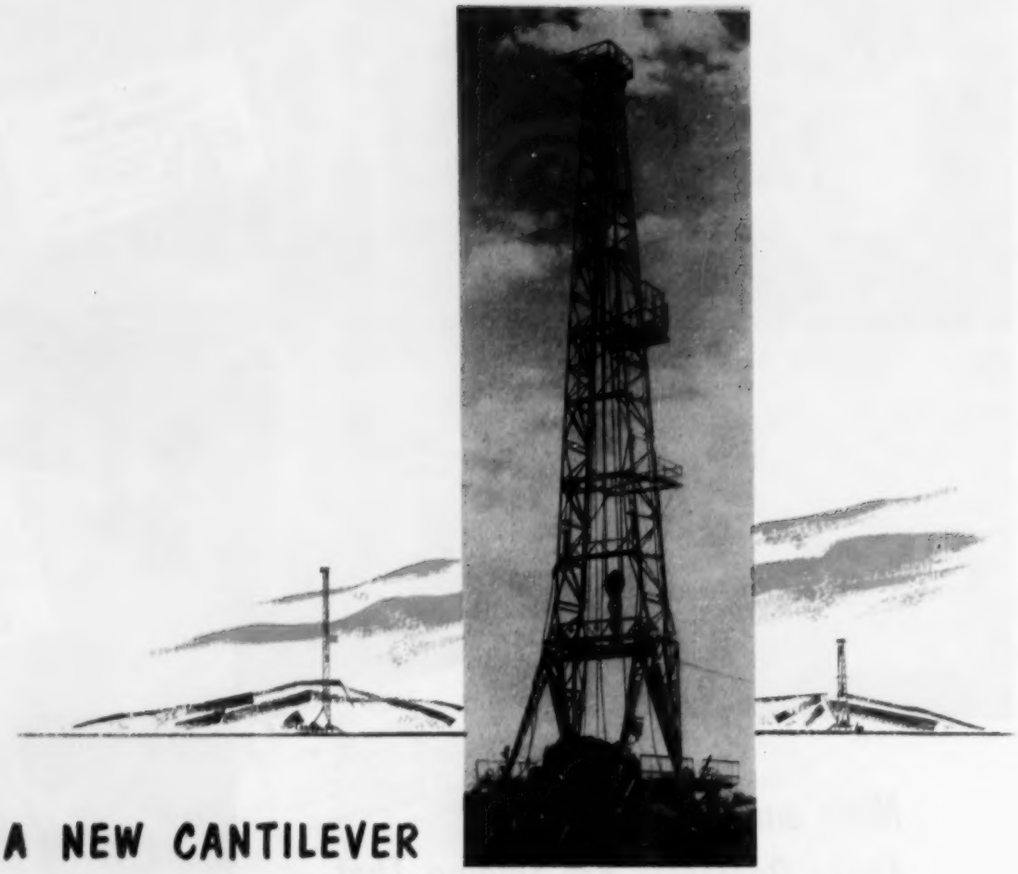

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FOR TOUGH, DEEP DRILLING JOBS—

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PETROLEUM CHEMICALS DIVISION
NEWS

March ★ One of a Series of Interest to the Petroleum Industry ★ 1955

HE SEES TWO PUMPS ...but his choice may be up to your dealers

Here is the second sales promotion booklet in the new series, "Looking through the windshield." It offers your dealers practical, concrete sales pointers on how to convert "regular" gasoline customers into "premium" users.

The "Looking through the windshield" series is designed and prepared to help you make better salesmen out of your dealers. It is based on information turned up by the recent Du Pont survey of Consumer Gasoline Buying Habits. The first one of a series, entitled "A close look at the man behind the wheel," tells how the dealer can increase customer loyalty.

The first two booklets in the series are now available for distribution to your dealers. Any Du Pont Petroleum Chemicals Division representative or regional office will be glad to give you sample copies . . . and cost information for ordering them in large quantities.

Cracked Stocks for Diesel Fuels?

Du Pont Fuel Oil Additive No. 2 helps provide the flexibility that makes this possible

With the rapidly expanding use of diesel power—coupled with a limited supply of straight-run distillate stocks—many refiners want an efficient way to adapt cat-cracked heating oils for diesel fuel applications. If you are concerned with this problem, the chances are good that Du Pont Fuel Oil Additive No. 2 can help you solve it.

The effective stabilizing and dispersant action of Du Pont FOA-2 can be very helpful to you for upgrading your heating oil stocks to diesel fuel. Du Pont FOA-2 also gives you added flexibility for blending cat-cracked with straight-run stocks.

Market Potential

What about the market for upgraded cracked stocks in the diesel field? Many of the railroads, for example, are now using cracked furnace oils containing Du Pont FOA-2 with good results. They have found, after careful, extensive testing, that they can efficiently operate diesel engines on well-stabilized furnace oils at substantially lower cost, and without harmful effects.

Any Du Pont Petroleum Chemicals Division representative will be glad to discuss with you how you can take better advantage of this growing market through the use of Du Pont Fuel Oil Additive No. 2.

New sales and technical service organizations set up to handle Du Pont additives

To further improve customer service, the Du Pont Petroleum Chemicals Division has set up new sales and technical groups especially to handle certain types of additives.

HEADS NEW SALES GROUP. Robert M. Glover has been appointed Assistant Sales Manager — Additives of the Du Pont Petroleum Chemicals Division, in charge of sales of gasoline additives and other additives except tetraethyl lead.

Increasing activity in these additives, as well as anticipated manufacture of others currently in the late development stages, make this expansion of services particularly desirable at this time.

Heading up sales activity in connection with antioxidants, dyes and Metal Deactivator for gasolines, and a dispersant and stabilizer for burner and diesel fuels, is Robert M. Glover, Assistant Sales Manager—Additives. Prior to this appointment, Mr. Glover was manager of the Division's Mid-Continent Region with headquarters in Tulsa, Oklahoma.

New Service Group

In addition to the sales organization, a special technical service group has been set up with headquarters at the Du Pont Petroleum Laboratory. This service group is under the direction of W. E. Bettoney, who will also act as assistant director of the laboratory. He was formerly an assistant technical manager of the Division.

Backed by the facilities of the Petroleum Laboratory, this group is in a position to offer exceptionally complete technical service for customers on all problems concerning the use of additives for petroleum products.

Two More District Offices Added

To facilitate faster and more convenient customer service in two important

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *New Organization*

areas, district offices have recently been set up in Philadelphia and Detroit. L. Z. Carey is in charge of the Philadelphia district and P. H. Richard the Detroit district.

In addition to sales activities, the Detroit office will maintain close contact with the automotive industry. Before assuming his new duties as district manager, Mr. Richard was one of the Petroleum Chemicals Division's automotive specialists.

W. E. Bettoney discusses a customer's problem with his associates. Mr. Bettoney is Assistant Director—Petroleum Laboratory, in charge of sales technical service. (l. to r., D. L. Postell, W. E. Bettoney, N. D. Lawson)

When are TWO additives CHEAPER than one?

There are many cases where the use of Du Pont Metal Deactivator in combination with other additives can result in substantially lower treating costs than the use of any single additive. This is true in stabilizing heating oils and diesel fuels as well as in stabilizing gasolines.

In Fuel Oils

Although DMD has considerable stabilizing value when used alone in fuel oils to prevent the formation of copper mercaptides, it is of maximum value when used in combination with an antioxidant and dispersant such as Du Pont Fuel Oil Additive No. 2.

And, since DMD is compatible with all known fuel oil additives, many refiners have obtained excellent results from using it in conjunction with their own additives. It also helps to improve color stability in cases where color deterioration is caused by copper contamination.

In Gasolines

The most common use of DMD is, of course, in motor gasolines. Surveys show that the great majority of all commercial gasolines contain significant amounts of copper. Therefore, since the Metal Deactivator can be used at a treating cost of less than ½ of a cent per barrel, many refiners now consider it cheap insurance to add DMD in combination with a regular antioxidant.

And most of these refiners have found that the DMD enabled them to achieve their desired stability level with smaller amounts of antioxidants—thus *reducing their total treating costs.*

Other Uses

Du Pont Metal Deactivator is also frequently used for stabilizing kerosene stocks that have been copper sweetened. In such cases, its color stabilizing properties are outstanding and it has been found to reduce carbon and coke formation in pot burners by as much as 50%.

In addition, it promises to be of considerable value for stabilizing aviation gasolines and for overcoming the tendency to cause nozzle fouling in jet fuels.

For full information on the properties, advantages and uses of this versatile additive, ask any Du Pont Petroleum Chemicals Division representative or regional office for a copy of our new Metal Deactivator booklet.

MID-CONTINENT REGIONAL MANAGER

DONALD W. FRISON was recently appointed manager of the Petroleum Chemicals Division's Mid-Continent region.

Mr. Frison joined the Du Pont Company in 1947 and served as manager of the Mid-Continent Regional Laboratory until 1951. He was then transferred to the Wilmington office as technical assistant to the director of sales. He later became assistant manager of sales promotion and then assistant manager of the Mid-Continent Region. Before joining Du Pont, he was engaged in CFR engine work and refined petroleum products analysis.

During World War II, he was a petroleum officer in the United States Navy Bureau of Ships and was engaged in tanker loadings at the New York Petroleum Pool.

Mr. Frison received his B.S. degree in chemistry from the John B. Stetson University in DeLand, Florida. He is a member of the Society of Automotive Engineers and the American Petroleum Institute.

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The Standard-Vacuum organization is continually expanding its educational and training programs for its 40,000 employees in the various areas where it operates.

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Stanvac seeks to do its part in developing the capacities of its employees so that they become better qualified to carry on the company's operations and to participate in supervisory and administrative functions.

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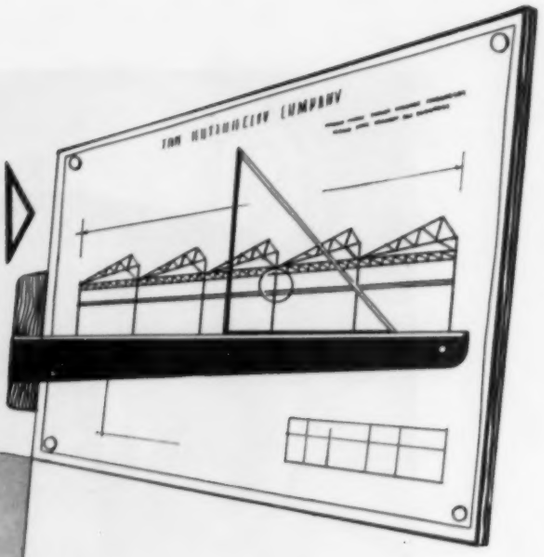
from drawing board



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The Butterley Company has been engaged in constructional steelwork from its early days and examples are to be found in all parts of the British Isles and in many countries overseas. From design, through the stages of fabrication to erection on site, every structure is invested with the skill and knowledge which have made the Butterley Company famous in the field of constructional steelwork. Welded methods are widely employed today and the shops are well-equipped to undertake the largest and heaviest work of this nature.

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CS-37

"...Small World"

Bechtel men are old hands at map reading, for in the course of developing resources for industry they travel to many far places. Here, for example, are Bechtel projects in one part of the world where total additional refinery and pipe line capacity of approximately 500,000 barrels per day has been added.

They illustrate the ability to move fast and furnish a complete service under single responsibility—*anywhere.*

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SAUDI ARABIA

• Trans-Arabian Pipe Line, construction of 753 miles of 30" and 31" Oil Pipe Line and 4 Pump Stations.

• Ras Tanura Refinery and Piers; Dhahran, Oil Handling Facilities, Arabian American Oil Company.

• Riyadh, Utilities, Community Facilities; Jidda, Port; Government of Saudi Arabia.

BAHRAIN

• Petroleum Refinery, Marine Terminal, Bahrain Petroleum Company, Limited.

KUWAIT

• 1 million barrels-per-day Oil Terminal, Pipe Lines, Gathering System. Kuwait Oil Company, Limited.

LEBANON

• Sidon Refinery, Mediterranean Refining Company.

IRAQ, SYRIA

• I.P.C. Pipe Line, Iraq Petroleum Company, Limited. 555 miles of 30" and 32" Oil Pipe Line.

ITALY

• Naples Refinery Addition, Socony-Vacuum Italiana, S. p. A.

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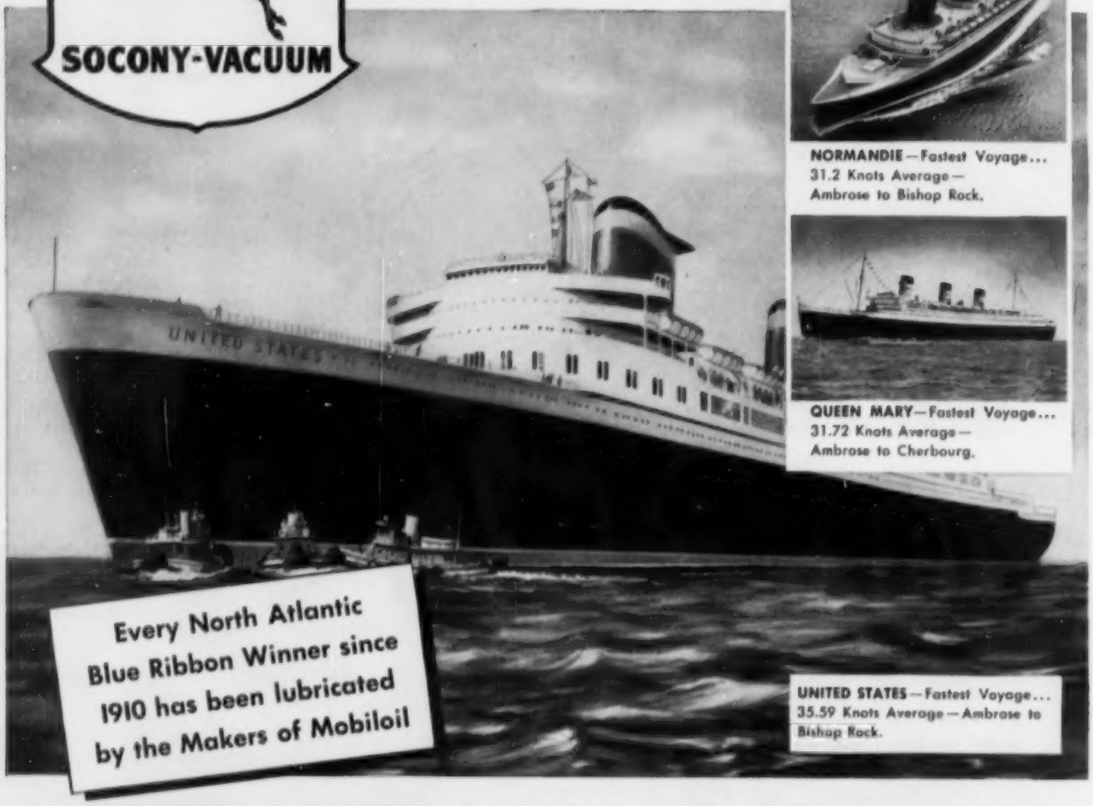
BREMEN—Fastest Voyage... 27.83 Knots Average—Cherbourg to Ambrose.

NORMANDIE—Fastest Voyage... 31.2 Knots Average—Ambrose to Bishop Rock.

QUEEN MARY—Fastest Voyage... 31.72 Knots Average—Ambrose to Cherbourg.



Every North Atlantic Blue Ribbon Winner since 1910 has been lubricated by the Makers of Mobiloil

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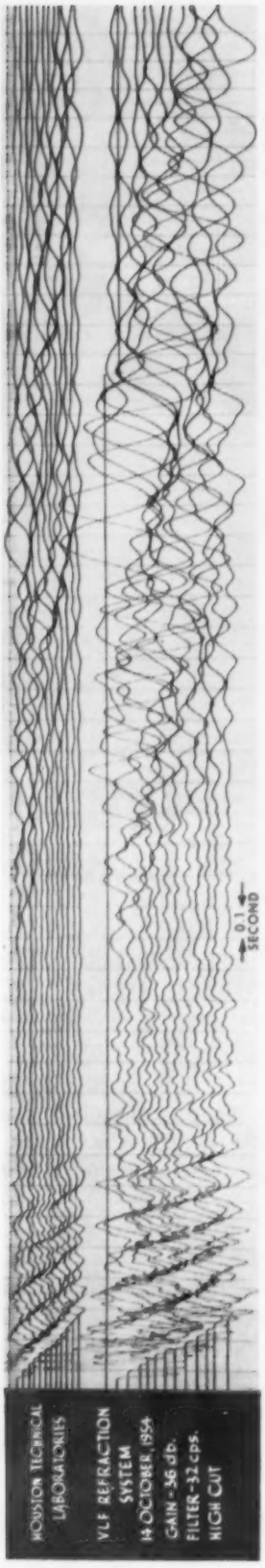

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VLF

2-CYCLE refraction system

especially designed for refraction work by HTL

The new Houston Technical Laboratories VLF (very low frequency) seismic refraction system is especially useful in areas unworkable with the reflection method. The VLF refraction system can be used in petroleum exploration, mining surveys, civil engineering, and ground water location and is capable of covering large areas quickly.

With excellent frequency response down to one cycle on the amplifiers and to two cycles on the seismometers, the VLF refraction system is exceptionally versatile in application. A combination of high cut filters provides a frequency cut-off range from 8 cps to 48 cps — low enough for good refraction work at extremely long ranges, yet high enough for all applications except those at extremely small ranges. Excellent first breaks have been received at a distance of five miles using only a five pound charge.

Portability of the new VLF system is achieved through compact design of the 12-channel amplifier unit which measures 16¼ x 16⅞ x 8¼ inches and weighs only 42 pounds. Two output signals from each amplifier channel are recorded on a standard HTL RS-8 recording oscillograph, with paper speed adjustable from 7 to 16 inches per second.

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For detailed information about the new VLF seismic refraction system, write for Bulletin No. S-308.

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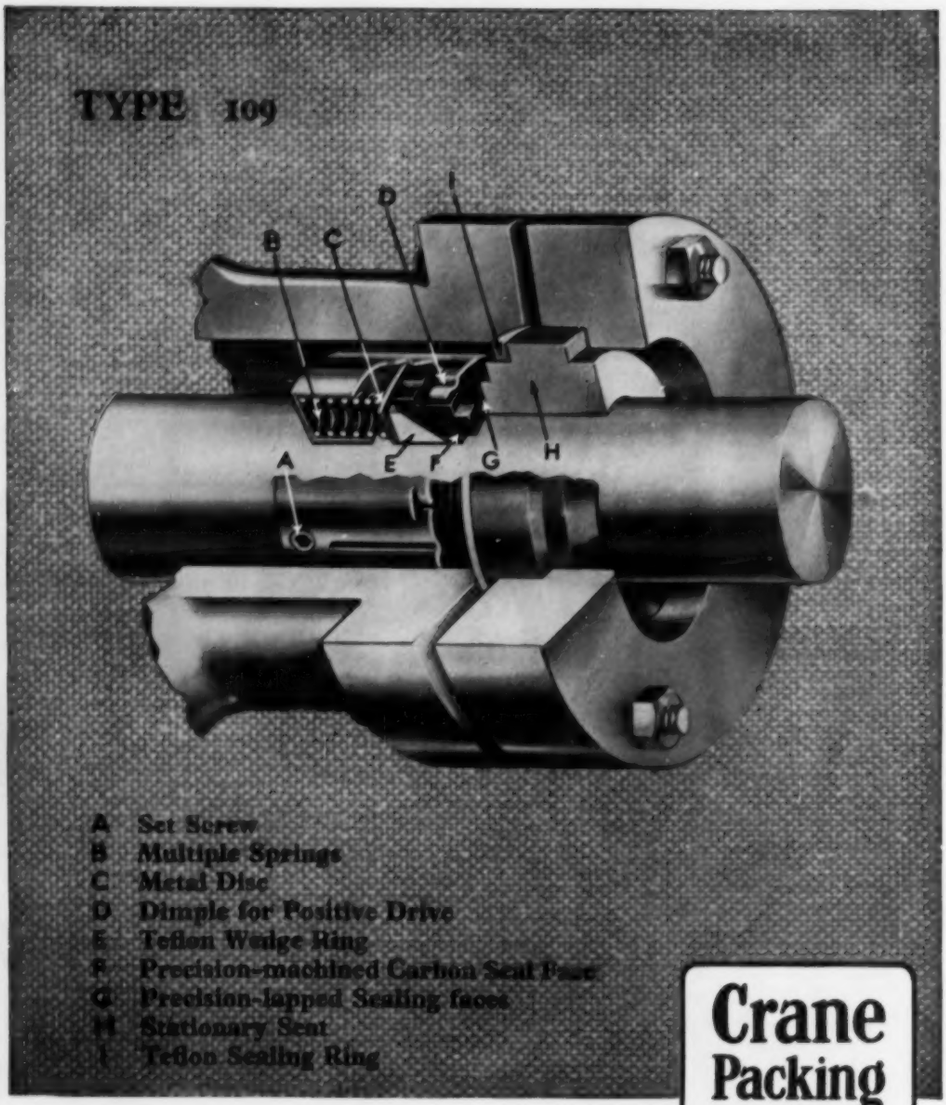
A Mechanical Shaft Seal



for High Temperature & Corrosive Services

Crane Packing LTD OF SLOUGH ENGLAND A COMPANY

This Type 109 Mechanical Shaft Seal will seal off corrosive fluids or gases which are being handled at temperatures up to 485° F. and at pressures up to 750 p.s.i. on such applications as centrifugal pumps, turbines, positive displacement pumps, agitators, etc. It is the first Seal of its kind to be manufactured in this country—it is precision engineered and corrosion resistant materials can be used for each component.

In order to impart to the assembly the required degree of flexibility a flexible wedge ring is used (see "E" on diagram). The new chemically inert polymerised plastic fluorethylene known as Teflon in the U.S.A. and as Fluon in this country, is the material from which this wedge ring is formed by means of special moulding and machining processes. All metal parts can be of stainless steel, or special alloys, depending on the nature of the service conditions.

Interested Engineers are invited to send for illustrated literature describing the Type 109 Mechanical Shaft Seal.

This is one of the many mechanical shaft seals which we manufacture for a wide range of services. We manufacture this design of seal by agreement with the Crane Packing Co. of Chicago, U.S.A.

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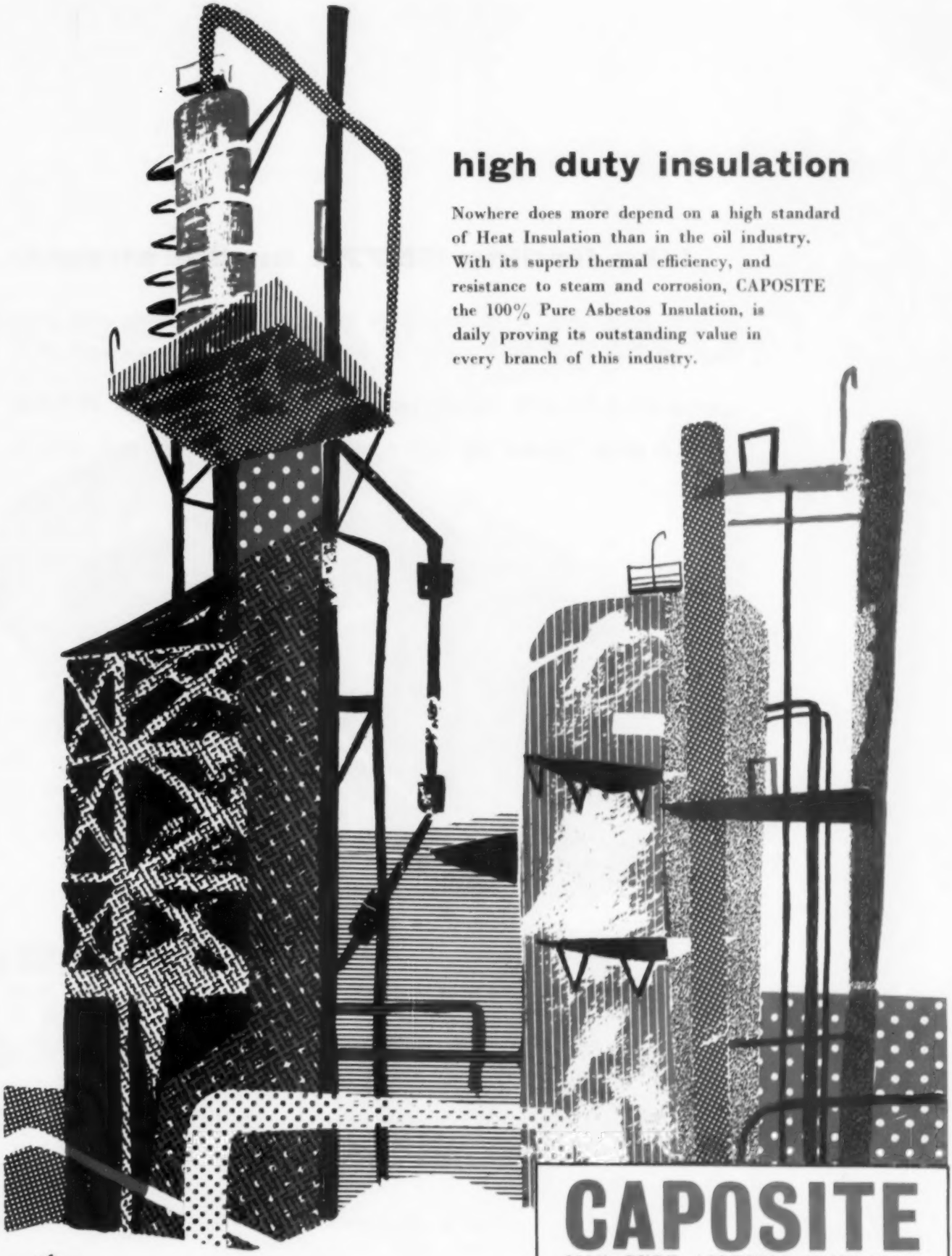

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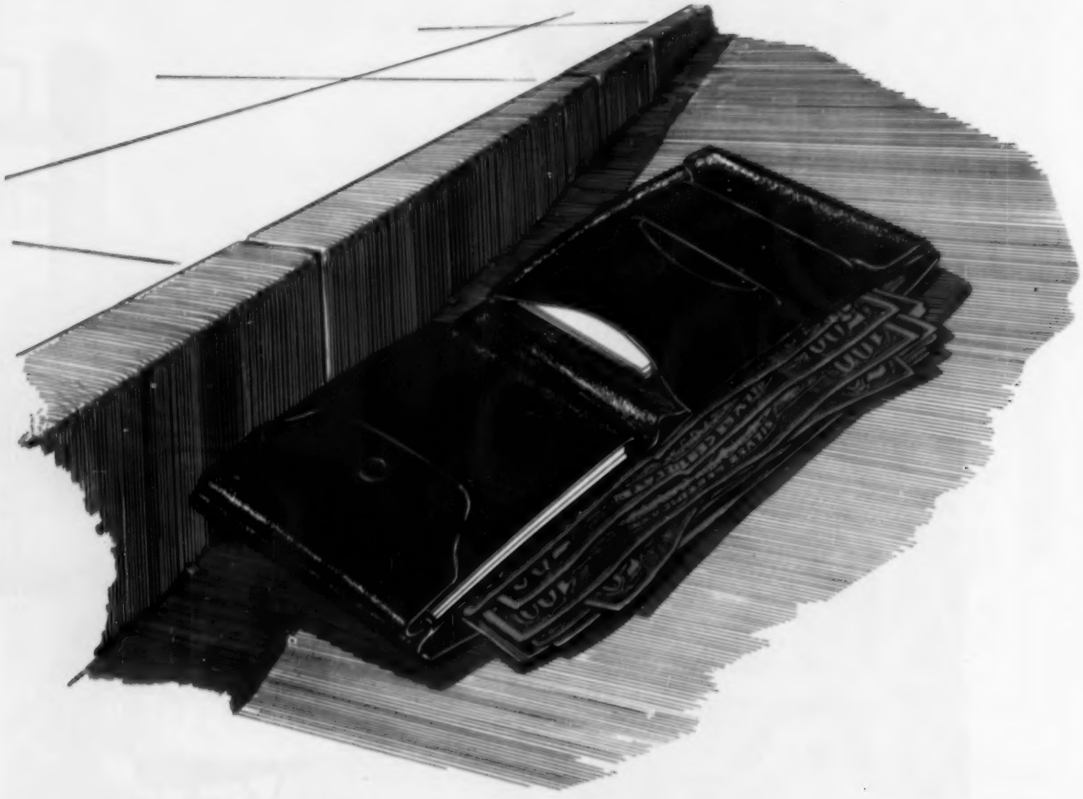

. . . that's what the

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of each Clark Turbocharged Compressor can save you annually in fuel alone

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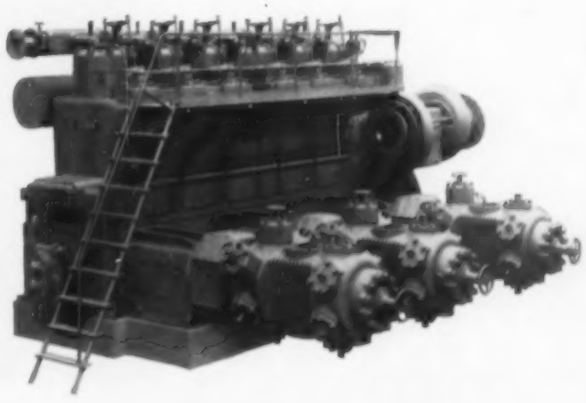

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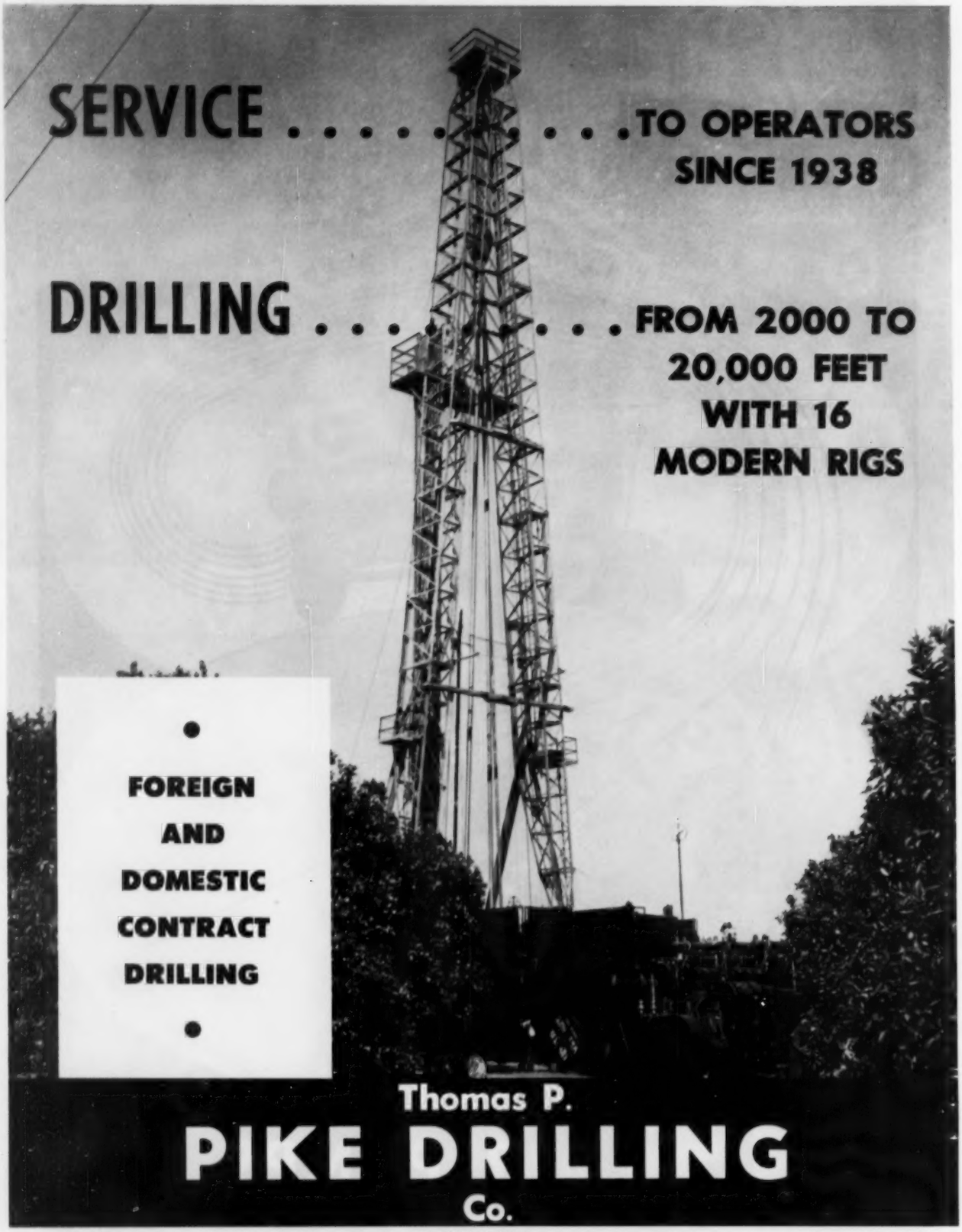
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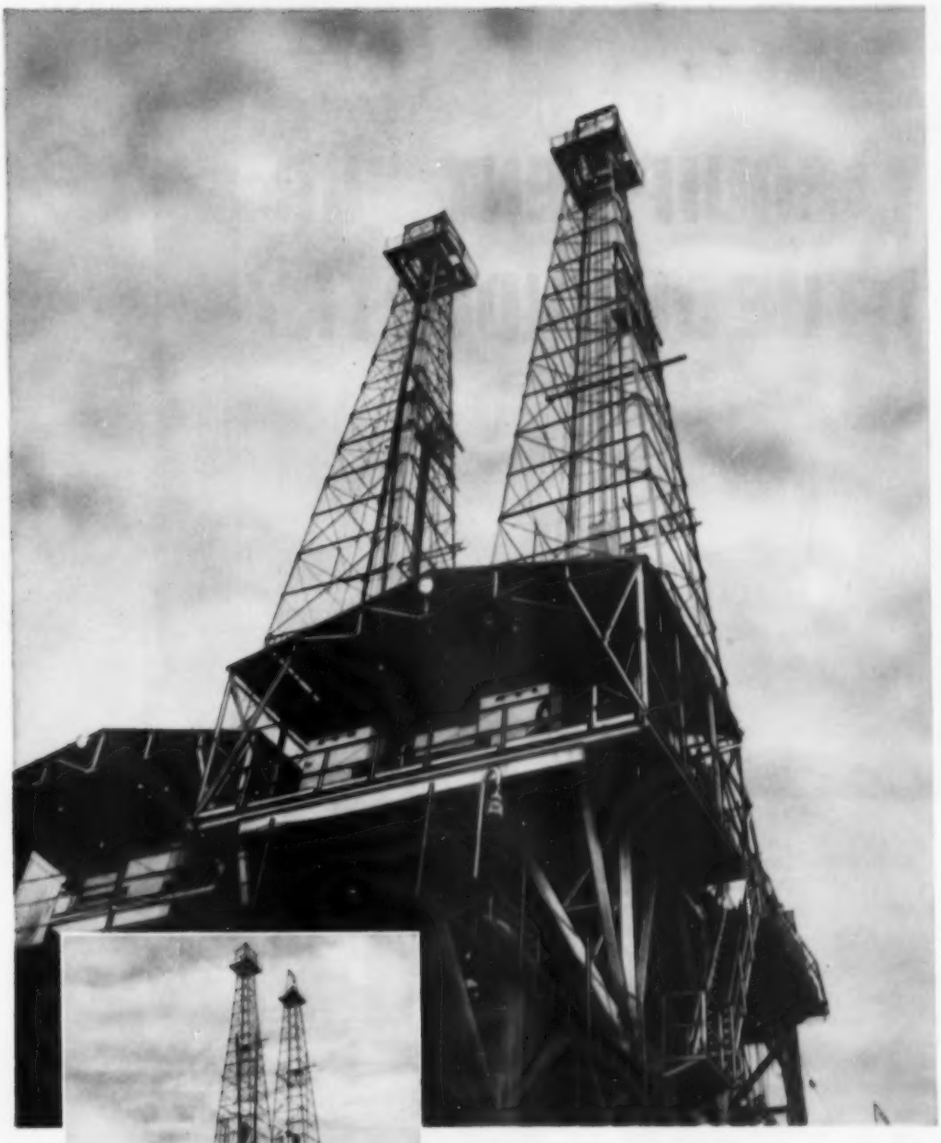
Avondale: a synonym for progress



Offshore drilling rig built by Avondale for the Oil Industry.

Avondale's Main Plant at Avondale, La. . . . ship and barge building and repairs, steel fabrication. Harvey "Quick Repair" Yard . . . quick repairs, drydocking, propeller service.

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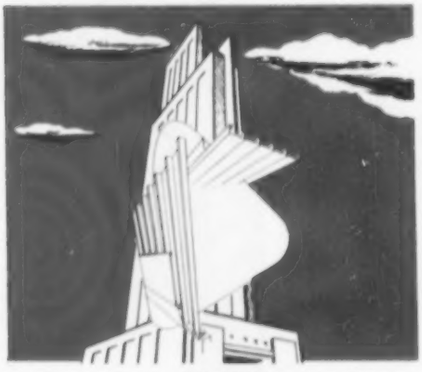

Avondale's new Avoncraft Division at Avondale . . . manufacturing architectural porcelain enamel load-bearing walls, load-span decking and curtain walls.

If progress is advancement, an evolution of growth through meritorious effort and acceptance of one's products and service—then Avondale is progress! In Fifteen years Avondale has grown from one division to four.

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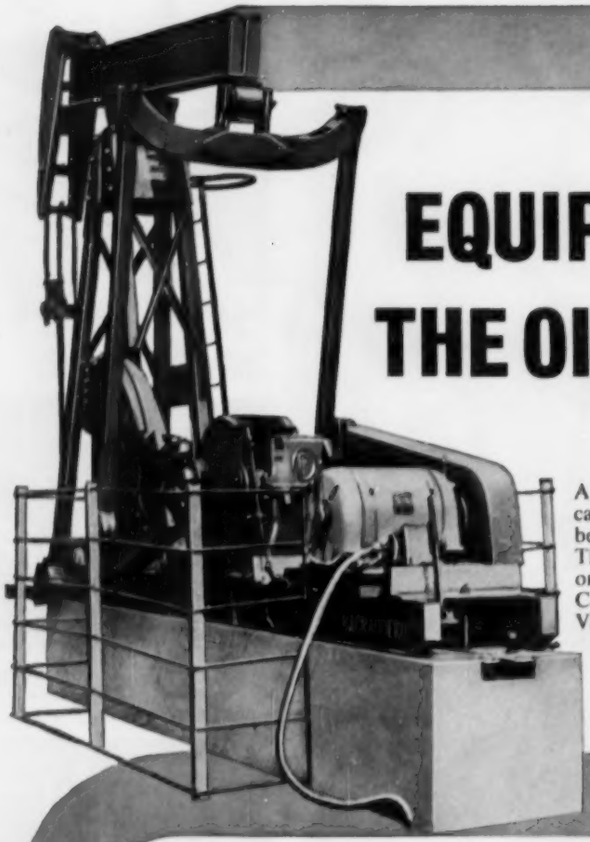
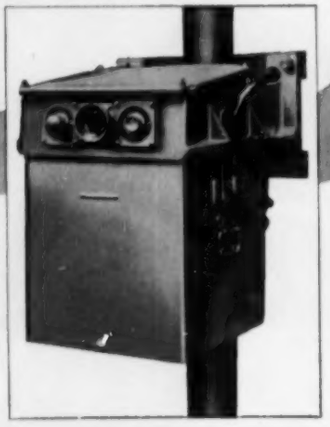
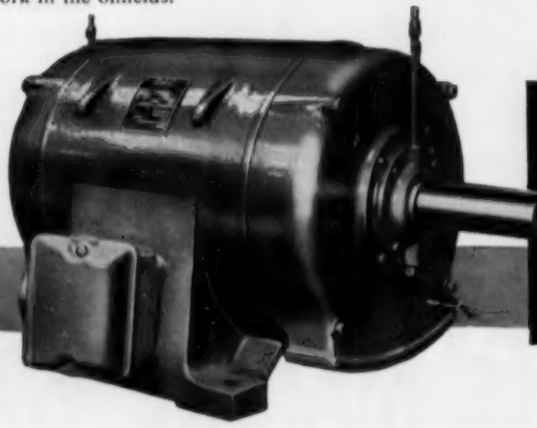


A high torque squirrel cage motor driving a beam type well pump. This installation is on one of the oilfields of Compania Shell de Venezuela.



A combined circuit breaker and contactor starter for the automatic control of oilwell motors.

A G.E.C. weatherproof motor designed and built for arduous work in the oilfields.



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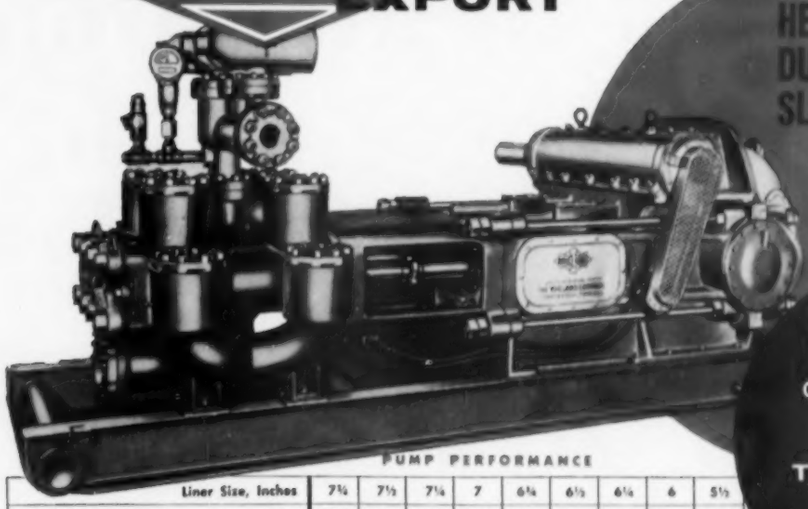

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HP 18,000—7¾" x 18"

750 HORSEPOWER at 60 R.P.M. and weighs only 36,320 lbs.

BUILT FOR FAST DEEP DRILLING

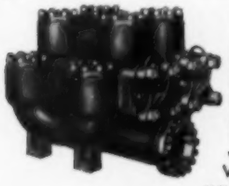
COMPACT • STRONG
BUILT TO LAST

THE PUMP FOR *JET* DRILLING

PUMP PERFORMANCE

Liner Size, Inches			7¼	7½	7¾	7	6¼	6½	6¼	6	5½
Maximum Discharge Gauge Pressure, PSI			1322	1419	1526	1648	1782	1937	2113	2314	2700
Speed of Crank RPM	Pump Horsepower Rating		Output in U. S. Gallons per Minute Pumped at 100% Volumetric Efficiency								
	Input	Output									
60	750	638	826	770	716	663	613	564	517	472	388
55	689	585	757	706	656	608	562	517	474	433	355
50	626	532	688	642	597	553	511	470	431	394	323
45	563	478	619	577	537	497	460	423	388	354	291
40	500	425	550	513	477	442	408	376	345	315	258
35	438	372	482	449	417	387	357	329	302	275	226
1			13.77	12.84	11.94	11.06	10.22	9.41	8.63	7.83	6.47

For complete details and specifications write for bulletin LE-182A



FLUID END

is a one-piece steel casting having one flanged suction opening, one studded discharge opening, eight separate valve pots with Wheland patented valve pot covers, Wheland back cylinder head and liner packing adjustment, tell-tale hole for liner packing, and screw type stuffing boxes fitted for circulating oil.

CRANK ASSEMBLY

Note the compact eccentrics integral with the crank. They increase the throw of the crank and permit the use of relatively small roller bearings in the connecting rod.

Main gear, connecting rods and bearings are assembled on the crank with through bolts and elastic stop nuts.

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1 CRANK in One Piece.
2 Cast Alloy Steel Heat-treated.
3 Eccentrics integral with crank pins.
4 Seat for main gear tapered, keyseated and flanged for bolts through gear hub.
5 Throw is part crank, part eccentric.

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All types of Oil Valves and Fittings for:

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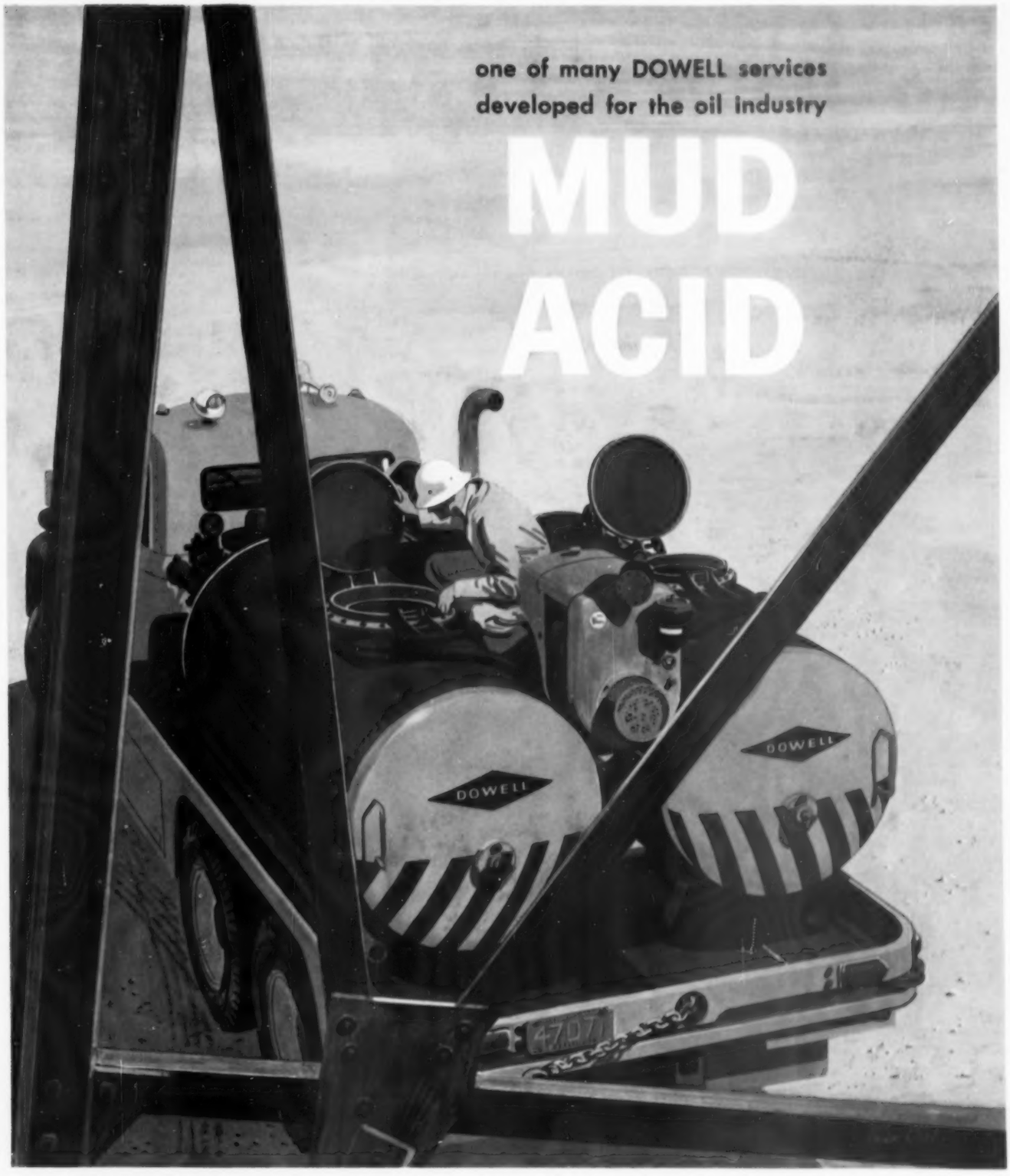

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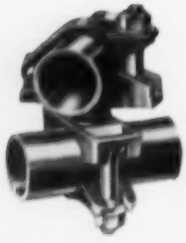

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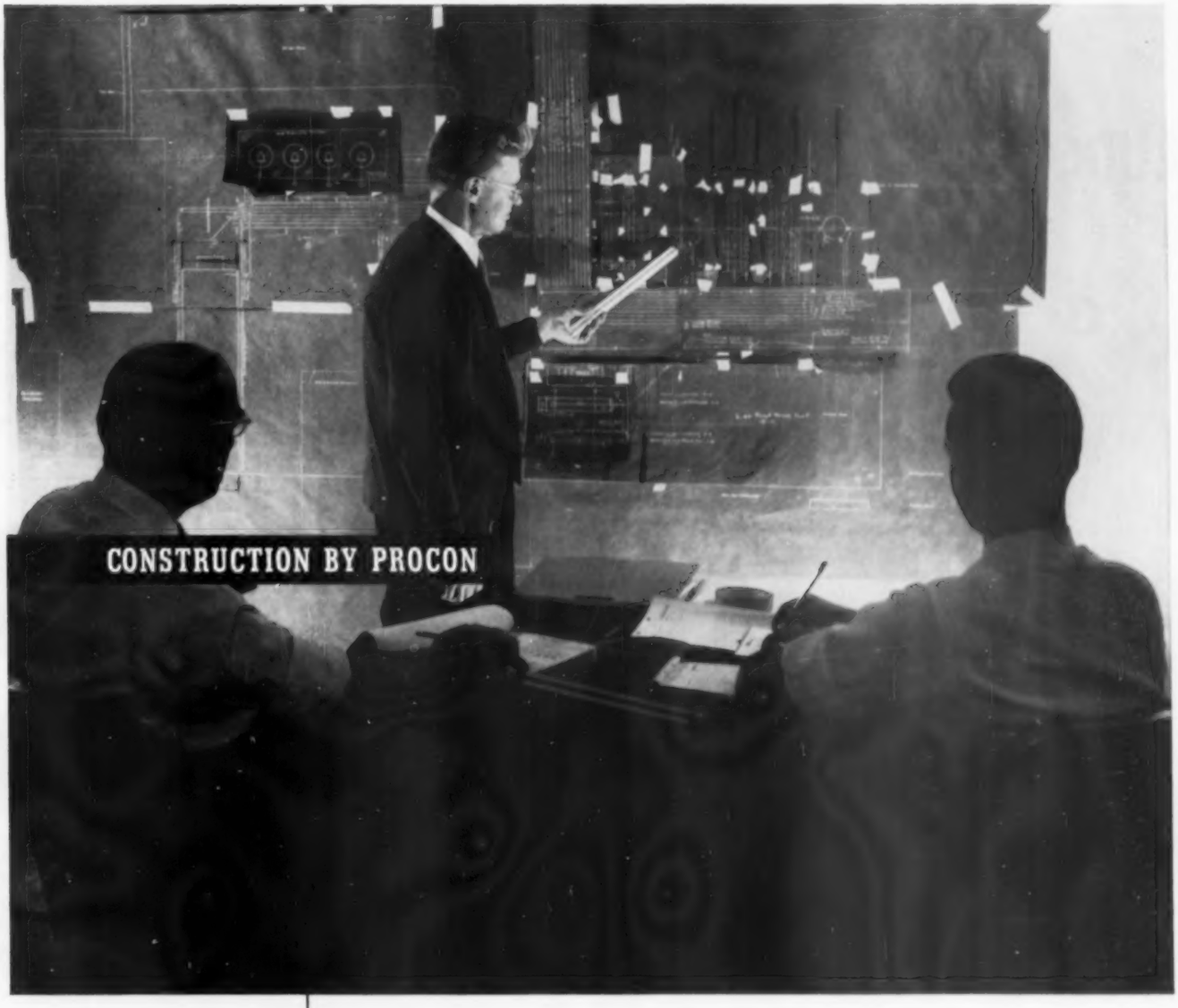

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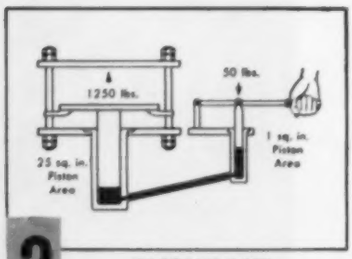
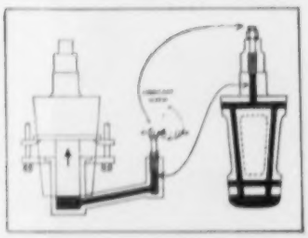
Here's Why AUDCO-NORDSTROM Valves Close So Tightly, Yet Operate So Easily

1 Audco-Nordstrom valves use the basic scientific principle known as Pascal's law, which says that "pressure applied to a confined fluid is transmitted uniformly to all areas of the confining surfaces."



2 PASCAL'S LAW

Here's an example showing how 50 pounds pressure on 1 square inch is sufficient to lift 1250 pounds when transmitted to a piston of 25 square inches.



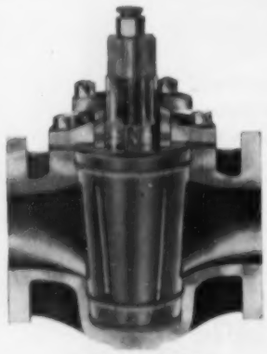
3 In Audco-Nordstrom valves, the lubricant screw applies the pressure to force lubricant through the grooves of the plug and give a powerful jacking action to lift the plug off the seat and keep the valve easy to turn at all times.

4 The grooves in the plug and body also distribute a film of lubricant across the seating surface, further sealing the valve ports against leakage, even in services where the line is carrying hard-to-hold fluids, vapors and gases.

5 If necessary, the plug can be instantly freed by a "shot" of lubricant from a pressure gun or by turning the valve lubricant screw. Operation is always easy because it's lubricated.

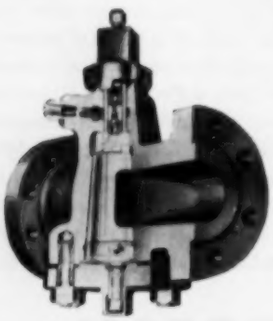
6 It takes only a quarter-turn of the plug of an Audco-Nordstrom valve to change it from fully open position to completely closed—one-tenth the time it takes to operate many valves.

7



There is a size and type of Audco-Nordstrom valves for nearly every service. Here's one with flanged ends and bolted gland. Screwed end or screwed gland patterns are also available.

8



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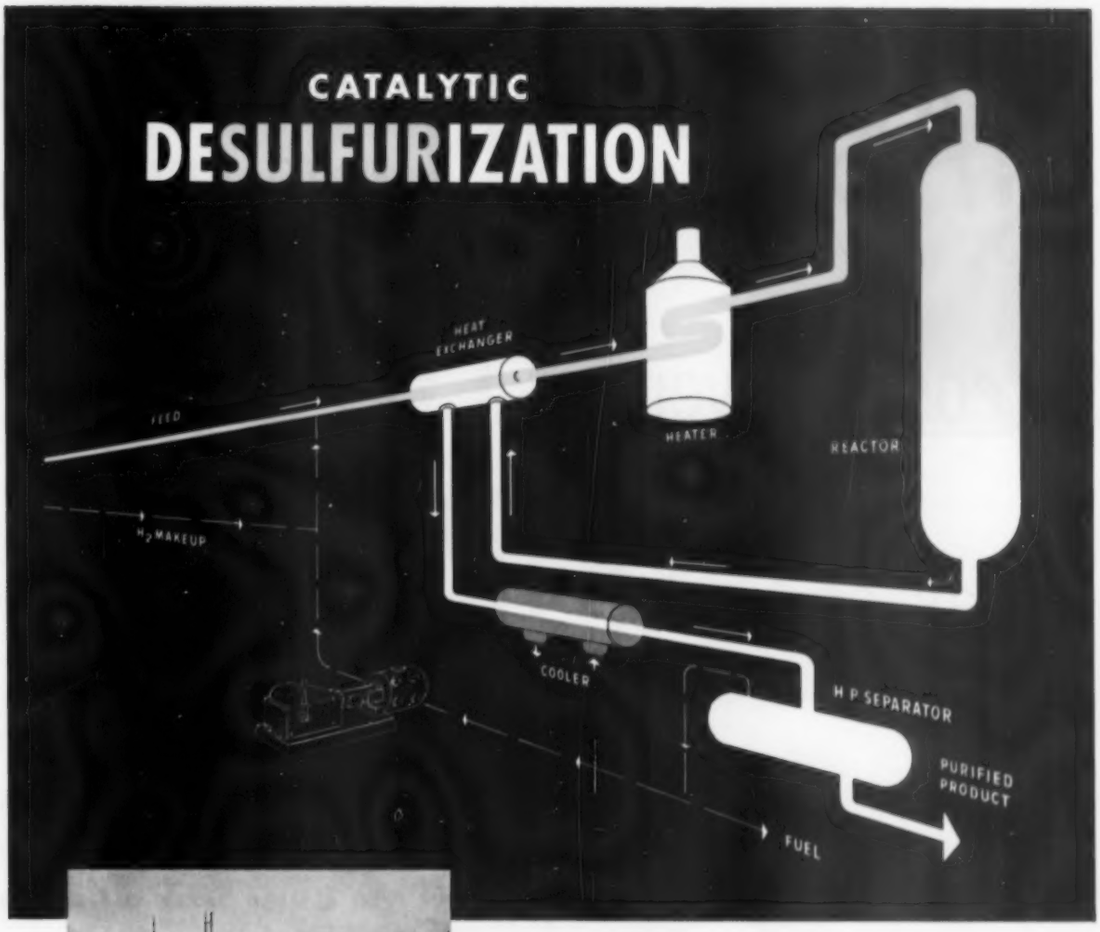

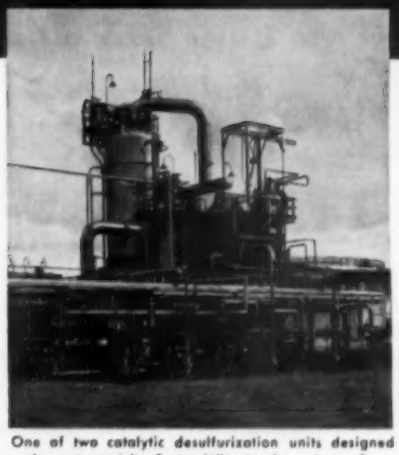

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For full technical details of this process, send for the Feb. 1955 issue of "Heat Engineering". Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.

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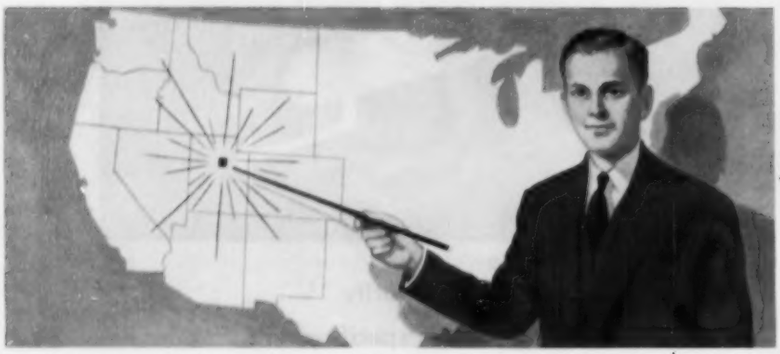

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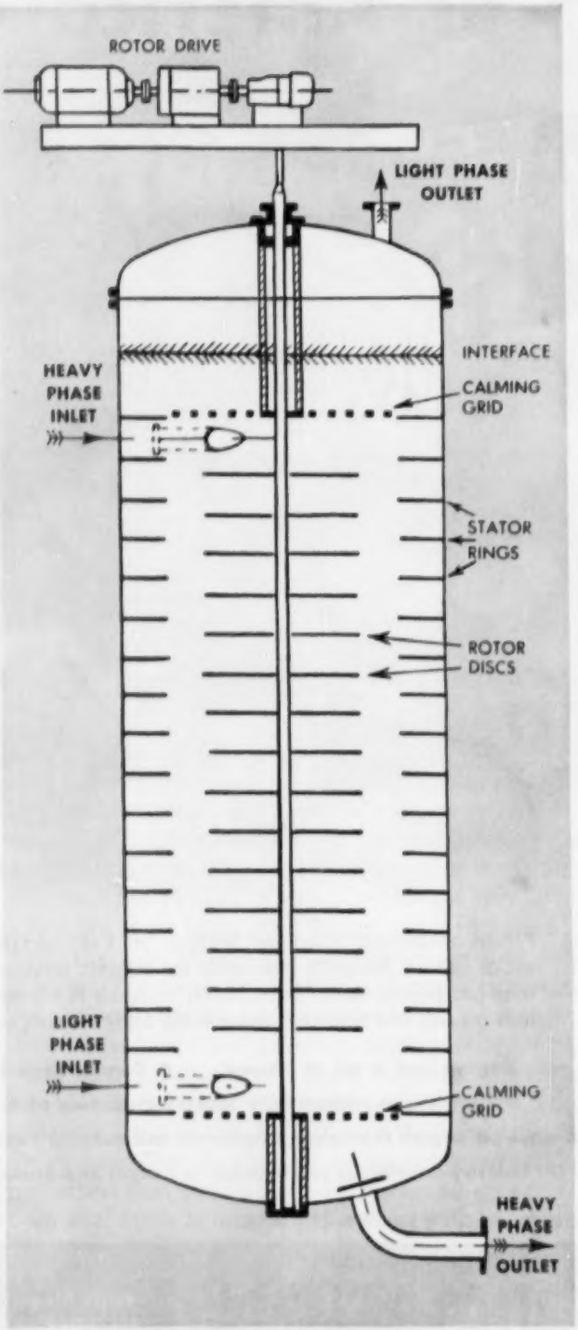
RDC improves extraction efficiency, cuts cost



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Mandan refinery starts up in three days

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DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

VOL. 26, NO. 3, MARCH, 1955

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THIS MONTH'S COVER

Helicopters are great time and step savers in transporting personnel, supplies, and equipment on oil exploration expeditions. The cover photograph shows the Associated Airways "chopper" used by Canadian Gulf Oil Co. coming in to pick up Gulf geologists Dr. A. Baillie and W. Wegmuller. Show in the background is the junction of the Liard and South Nahani Rivers in the Mackenzie district, Northwest Territories, Canada, about 750 miles northwest of Calgary. Color plates are reproduced through the courtesy of Donald C. White, editor of *The Orange Disc*, Gulf house magazine.

TRUTH DETECTOR TEST

The hardest lesson oil men learned was that a show of oil didn't always mean a well. A sample from the drill stem test just indicates production is *possible*. Whether or not the sand will produce is determined by subsurface pressures. And that's when you want the most precise pressure recording device . . . Halliburton's Bourdon Tube. The "BT" is a truth detector . . . for this supersensitive instrument makes the most accurate, detailed pressure recording on a coated copper chart that cannot be faked or hand-drawn. After a field reading the chart goes to Halliburton's testing headquarters where trained "BT" specialists rigorously inspect it under a micrometer optical chart reader. The report you get back is the surest possible way to know you've got a well before setting casing. Let your nearby Halliburton testing operator give your well the truth detector test.

211 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG

HALLIBURTON OIL WELL CEMENTING COMPANY
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Marine drilling opens new era

A NOTABLE FEATURE of the search for petroleum during 1955 will be the increasing attention paid to marine exploration. Events have been shaping for several years to make this a logical development and interest has been accelerated since the Congress of the United States enacted legislation defining the respective fields of the state and federal governments in regulating the search for oil and since numerous state governments have published claims to all mineral resources in the waters of the so-called continental shelf areas around their shores.

Knowledge of the existence of liquid hydrocarbons and other valuable deposits beneath the waters that cover the major part of the earth's surface is of course nothing new. Production of petroleum from underwater sources in certain locations has gone on for many years. Important fields developed in Lake Maracaibo, Venezuela, in the Pacific along the California coast, in the Caspian Sea off Baku and in various other spots have contributed substantially to the petroleum supply. In general, however, and until recently, this production has come mainly from enclosed waters such as seas or bays or from locations so close offshore that the methods of exploitation employed on land were applicable.

In the development of the coastal belts of Louisiana and Texas, the gently shelving beaches, extending offshore at shallow depths for miles in many places, were a constant challenge to explorers who gradually ventured further out and meanwhile learned the requirements of drilling in increasing offshore depths. A decade ago producing wells were in operation nine miles beyond the official Louisiana shore line.

Since that time the petroleum industry has spent thousands of millions in educating itself for the successful location and recovery of oil from marine depositories. Geophysical equipment, adapted to underwater reconnaissance, has revealed the same types of structures that have been prolific in yield in land drilling. A revolution in the construction and servicing of the structures from which marine drilling is conducted has taken place and further improvements are constantly being introduced, communication systems to give warning and defense against the hazards of wind and weather are being installed and means for the storage and transportation of production to land bases have been worked out. An entirely new art of locating and handling oil from ocean depths of up to a hundred feet or more has been evolved and further refinements of methods and equipment are constantly being studied and put to test.

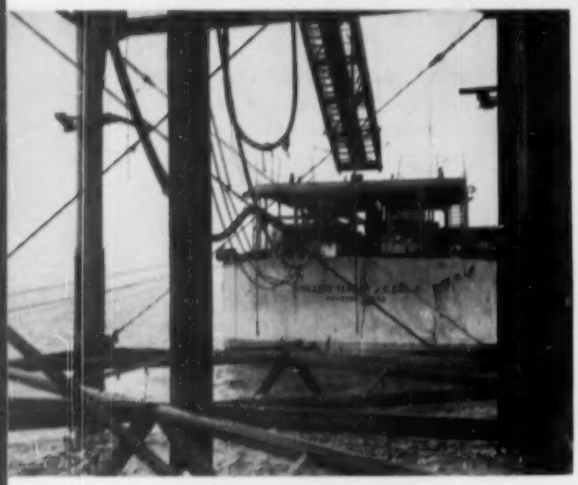
The significant distinction between past and present attitudes toward the search for oil in submarine areas is sufficient to mark the beginning of a new and important era in the development of the industry. In earlier years underwater drilling in most cases was an isolated attempt to determine the presence or absence of oil in a particular location. Today it is an organized campaign, based on the knowledge that vast deposits of the world's most useful form of energy rest beneath the waters that cover the earth, and backed by a determination to bring to bear all the skill and scientific knowledge necessary to make these resources available. Nobody knows the exact extent or location of all this undetermined wealth. Some guesses are that marine exploration will add 25 percent to present known petroleum reserves; others predict a doubling of presently known supplies.

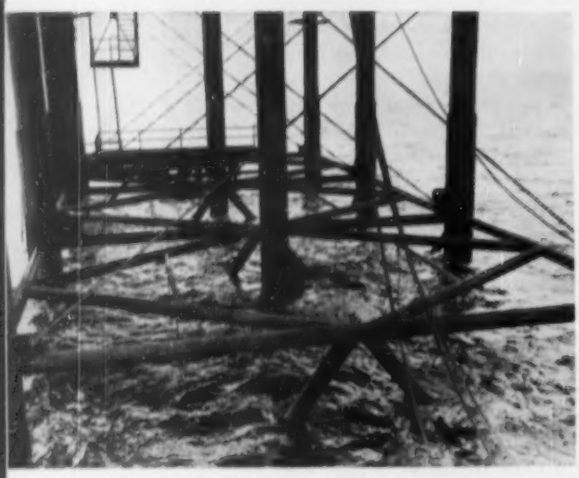
An indication of the value which the industry places upon potential marine deposits is afforded by the bonus prices paid for leases to explore and drill for oil. At the first sale held by the state of Louisiana directly following the late war, the average price received was slightly over $5 an acre. At the sale held in Texas a few months ago, one large tract brought $532 per acre, while at a similar sale in Louisiana, a top price of over $1,000 an acre was obtained. These, of course, are extreme figures based on preliminary indications that certain locations offer unusual promise.

In opening this new and exciting chapter of petroleum development, oilmen are well aware that the conditions of obtaining oil from underseas make it a more expensive process than land drilling to like depths. Through changes already introduced, the gap in costs between the two is being reduced and further reductions are probable. After all, differences in costs disappear if a 25 million barrel field is located.

The tender "J. C. Craig" from the derrick floor, showing the pipe racks, which have a capacity for about 45,000 feet of drill pipe, casing and tubing. The 70-foot boom Link Belt crane amidship is for unloading pipe from barges alongside the tender. The hatches seen on either side of the crane boom are for loading bulk mud and cement.

The stern of the tender is seen through the understructure of the drilling platform. Templets of heavily braced steel tubing form the foundation of the platform. Piling is driven into the floor of the ocean through these tubes. In the center is the 30-inch casing of the well just completed. A platform of this type, built for six wells, costs approximately $350,000.





Understructure of the drilling platform as seen from the deck of the tender. Mud pits aboard the tender supply drilling mud to the rig through the lines shown here.

Logistics of offshore

By James W. Calvert

IN A BROAD SENSE, logistics is an all-inclusive military term involving locations and distances translated into terms of fuel, endurance, supplies, food and other essential stores on hand or to be made available.

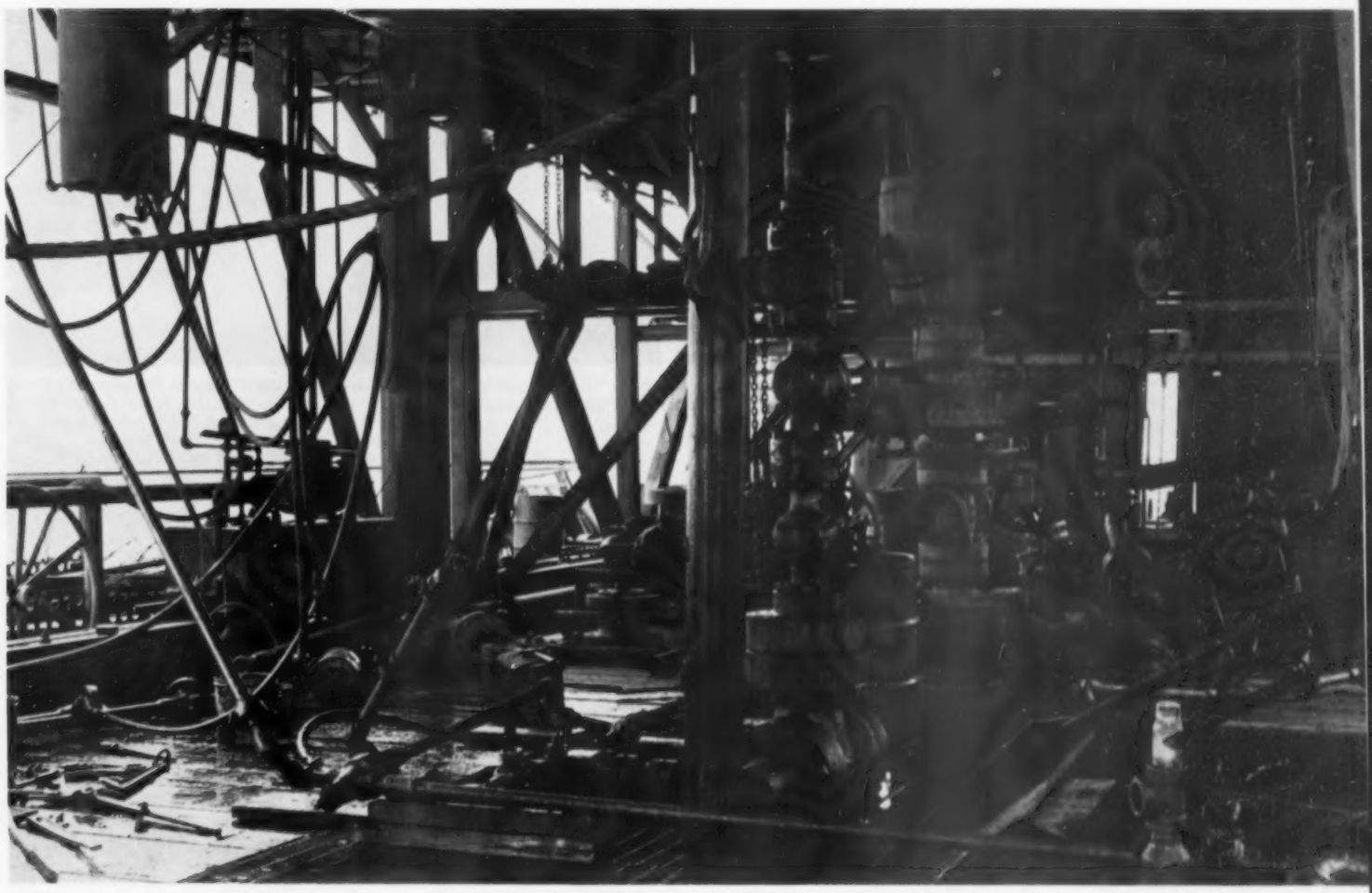
The maintenance of adequate stocks of logistic materials involves transportation which, when required to be conducted by sea, adds to the considerations with which military strategy is concerned and emphasizes the importance of what are known as lines of communication.

Logistics is a military term, but probably no other peace-time civilian operation is so closely related to logistics as is offshore prospecting for oil and gas.

A military campaign in a foreign land could be no more remote than drilling for oil in the submerged fields of the Gulf of Mexico off the coasts of Texas and Louisiana. The distances involved may not be as great, but the problems are just as brow-furrowing.

Where the military strategist thinks in terms of men and munitions, the oil executive must think in terms of men and the intricate machinery necessary to bring petroleum to the surface and to transport it to the refineries for processing into a useful consumer product. Fundamentally, their methods are the same; the only difference is in the end result.

If anything, the oil man will undergo the more nerve-wracking experience, for while the seaman is trained in the



The CATC wildcat was being swabbed when this photo was taken in the "cellar" of the well. The Cameron blowout preventer at right had been set aside to make way for the Christmas tree.

oil prospecting

vagaries of the sea and weather, the oil man is a prospector into the depths of the earth. He is an industrialist whose normal operations are hampered by the unnatural obstacles created by the seas. There has long been an axiom, however, that pretty much pertains to all prospecting:

"Oil (or gold) is where you find it."

Ergo, if oil is to be found in ten, a hundred or six hundred feet of water, that is where the oil man will go to look for it, regardless of the hardships and the difficulties he may encounter en route.

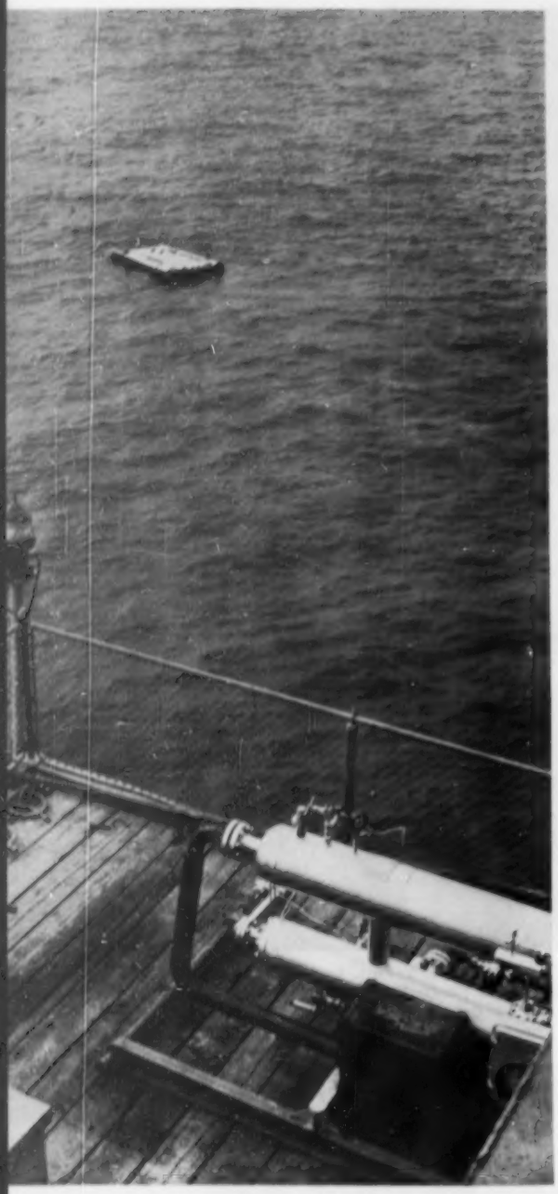
The continental shelf is an extension of the coastal plain that slopes gradually from a point 600 feet above sea level to a point 600 feet below the surface of the ocean. In width, the continental shelf of the Gulf of Mexico ranges from 15 to 140 miles and the proven oil producing areas are bounded in a region extending from Brownsville, Texas, to the Mississippi River passes and beyond.

The geological formation characteristics of the Gulf coastal region, both on shore and offshore, were caused by a retreat of the sea in what geologists know as the Tertiary Age. From north to south, from Central Louisiana and including the offshore areas, the sediments probably are younger but similar in character to those found farther north. The sands and shale look the same, and geologists are of the opinion that offshore submerged lands will be as productive as the areas which run parallel to them in on-shore fields.

It has taken half a century to develop the onshore fields. Probably it will take as long to develop those in the offshore areas. New methods in drilling, exploration and production may speed up this development to some extent. If the industry were still using the old cable tools of half a century ago, the job of drilling for oil and gas in the submerged fields would look like an impossible task.

Offshore drilling is very much in its infancy. It looks as though there will be a long, long way to go.

And since the oil man operating in offshore locations has no alternative but to float, or fly, his men and materials to their work, there will always be an unending



U. S. Coast Guard regulations require that all obstructions at sea be properly marked with aids to navigation, such as the flashing light pictured on one corner of the CATC offshore platform. In the background is one of the mooring buoys for the drilling tender. In the right foreground, on the top deck of the platform, is a National Tank high pressure separator.

Workmen aboard the "J. C. Craig" secure tubing to the deck with straps. Heavy seas are a serious problem for pipe handling.

race among designers, shipyards and operators to create more efficient seagoing equipment in an effort to make the task less difficult and less costly.

Scientists are now at work on formulae and methods which, they hope, may someday be used to dispel storms at sea as effectively as they have learned the secret of creating rain by seeding the clouds.

Until that occurs, however, the oil prospector will always face one constant obstacle—bad weather at sea.

The coastline of Louisiana and Texas fronts on the broad Gulf of Mexico, with a clear sweep of the tropics. The period of roughest weather in the Gulf is during the summer and early fall. This is the tropical hurricane season and prevailing winds are from the east, southeast and south, traveling for great distances to whip the seas into enormous swells before they reach the offshore rigs.

During this season the winds are of greater velocity and their greater "fetch" results in rougher seas.

Even in the winter months, when prevailing north winds blow off a lee shore, there are many work stoppages due to weather. The passage of a typical cold front, caused by what meteorologists call an extra tropical low, will be preceded by several days of strong south winds to be followed by a sudden shifting of strong winds from the north.

The storm of last January 17-18 is a good case in point.

At 6:30 a.m. on January 17 the weather map showed no evidence of a disturbance, yet during the day and night such a severe storm developed that drilling rigs had to be shut down, floating tenders had to slip their moorings and drop anchor and drilling crews speeded to the safety of shore bases.

At 6:30 a.m. on January 18 the storm was over Lake Charles, La.; at noon it had reached McComb, Miss., and at midnight it was off the Georgia coast.

Drilling operations could not be resumed for a full day. While alert private weather forecasters were able to detect the approach of the storm in time to avert widespread damage, at least one string of drill pipe was lost at sea when it was washed off a barge en route to an offshore location.

This was one of the "bad" days on the Gulf. There were gusts of wind recorded up to 60 miles an hour. Weather of far less intensity will seriously hamper normal drilling operations.

For example, there are an average of 20 days during the year when supply vessels cannot move because of fog or bad weather. During 20 more days the vessels cannot lay alongside the rigs or tenders to load, because of rough seas; and on five days the drilling tenders must be moved away from the rigs and lay-to waiting for weather to abate.

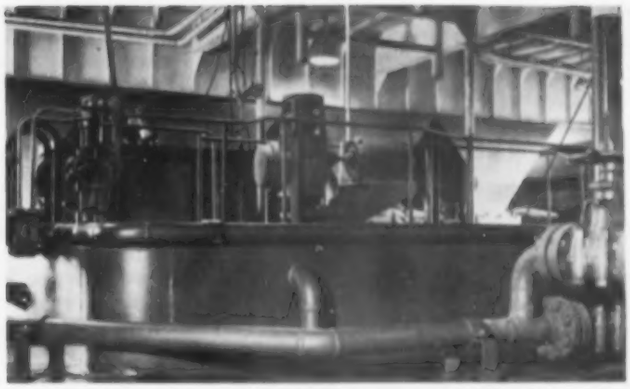
These are average conditions, based on 50-year records of the United States Weather Bureau.

In the case of a "norther," offshore oil operations are frequently handicapped in still another manner. A strong north wind blowing for days off the Louisiana and Texas coast will blow water out of the bays and inlets, making it impossible for floating equipment to operate. Rigs working in the shallow areas of the coastal region will be virtually stranded, being unable to get in or out with materials and supplies.

Seamen judge the intensity of sea conditions by the height of the swells, or waves, measured from the bottom of the valley to the crest of the wave.

Drilling at sea is hampered when swells are eight feet or over. The rolling of a floating tender makes it virtually impossible to handle pipe. One of the arguments

Main power plant of the CATC drilling tender "J. C. Craig." It consists of three Superior PTDS-8 diesel driving engines, each rated at 650 bhp at 900 rpm. They power the three National Supply Co. Ideal E-500 pumps which circulate drilling mud from the active and reserve mud pits on the tender to the derrick floor.



Active mud pit on the tender and one of the two "Lightnin' " mixers. An Allis-Chalmers 15 hp electric motor drives the mud mixer. Bulk mud hoppers may be seen in the background.

in favor of the large self-contained permanent platforms, or the self-contained submersible drilling barges, is that they are able to operate with fewer work stoppages due to abnormal sea conditions.

Nash Roberts of New Orleans, one of several private meteorologists serving the offshore oil industry, has worked out a table of averages for various types of marine operations.

For example, deep sea tugs handling oil and water barges, derrick barges, drilling tenders and other large vessels, can maneuver safely and efficiently in seas ranging from zero to three or four feet; marginal operations are possible in seas ranging from three to six feet, but anything over that is considered dangerous and inefficient.

Personnel can be landed safely and efficiently from large boats or seagoing tugs in seas ranging from zero to four feet; marginal operation is permitted in seas up to seven feet, but is regarded as dangerous in higher seas.

Large amphibious aircraft can land safely in seas ranging from zero to one and one-half feet; from one and one-half to three feet is considered marginal; over three feet is dangerous.

Small aircraft: zero to one foot, safe; one to two feet, marginal; over two feet, dangerous.

Chain handling on derrick: zero to two feet, safe and efficient; two to three feet, marginal; over three feet, dangerous.

Lifting substructure by derrick: zero to two feet, safe and efficient; two to three feet, marginal; over three feet, dangerous.

Platform building: zero to four feet, safe and efficient; four to six feet, marginal; over six feet, dangerous.

Pipe line construction: zero to three feet, safe and efficient; three to four feet, marginal; over four feet, dangerous.

Employment of the private forecasters is an expensive item not generally budgeted in normal land operations, but the oil companies have found that in open water work their services are well worth their costs.

The United States Weather Bureau has only one reporting station along the entire Louisiana Gulf coast. This is at Burrwood, near the mouth of Mississippi River's Southwest Pass. Private Weatherman Roberts has four such stations along the coast, while others in the private forecasting business have their own stations and there is a constant exchange of information between them. Actually these private forecasters employed by oil companies frequently supply valuable information to the United States Weather Bureau.

Often the first indication of approaching bad weather is the irregularity of the tides. If there is a larger swell than is indicated by surface winds, it might well signal the approach of a distant storm. During these periods the observers report every half hour the tidal and sea conditions, noting particularly the direction and height of the swells. They ask for reports from ships at sea.

Weather reports are delivered periodically during the day to the oil companies and they, in turn, transmit the reports to the offshore rigs by radio. Regular weather reports, posted on bulletin boards on the rigs and in the drilling tenders, have a strong morale effect for they make the drilling crew aware that someone is looking after them. It is heartening to know that you will be warned of an approaching storm in time to get safely ashore.

Loss from storms in the Gulf has been relatively small because the oil companies are constantly vigilant for the first signs of danger.

Incidentally, Weatherman Roberts, who is a popular television weather forecaster and is a member of the Louisiana State Board of Education as well as being active in civic affairs in New Orleans, was the subject of an article which appeared in the September 1953 issue of WORLD PETROLEUM.

With oil prospecting underway in locations ranging from three to 55 miles distant from the nearest shore bases, it is obvious that ocean-going vessels of various types and designs are playing an enormous part in the development of the offshore fields.

Engineers of the CATC group, a syndicate composed of Continental Oil Co., Atlantic Refining Co., Tide Water Associated Oil Co., and Cities Service Oil Co., with Conoco being the operator for the group, have estimated the type and quantity of floating equipment needed for each offshore well.

They divide the operation into five phases.

Phase 1, the geophysical survey work, requires two boats which, of course, must be large enough to sustain themselves for many days at sea.

Phase 2, well staking, requires a 65 to 85 foot boat and a small plane or helicopter for vectoring. Exploration offshore is largely sub-surface geology and involves the constant correlation of electric logs and other scientific information. A single seismographic crew may cost $75,000 to $100,000 per year; but where a land crew can make only about 10 to 15 tests per day, in drilling holes and shooting, a crew at sea can make as many as 200 tests per day.

Phase 3, platform erection, calls for a 300-foot derrick barge, three 100-foot material barges, two 750 hp tugs and three 65 to 85-foot crew boats.

Phase 4, drilling operation, requires a 260-foot non-propelled drilling tender

A 10-place Sikorsky S55 helicopter lands on the tender's flight deck to discharge part of the relief crew. CATC crews work 10 days on and five off. Helicopters quickly transfer the personnel from shore bases to the offshore rigs.

which will provide quarters for the drilling crews, storage for pipe, mud, cement, and other supplies, and power for mud pumps, generators and other machinery. To move the tender to location and to standby it during the drilling operations will require the services of a 750 hp tug. Other floating equipment needed for this phase of the prospecting operations will be two 100-foot material barges for moving materials and supplies to the rig, and four 65-85 foot crew boats for transporting personnel, company officials and visitors.

Finally, phase 5, the production operation, will require three crew boats and such barges or tankers as are necessary to collect the production of the well and transport it to pipe line terminal or refinery, unless a pipe line has been constructed to the well.

With approximately 400 wells drilled on the Louisiana continental shelf since 1947, and some 40 active rigs now operating, it is not difficult to estimate the demand to be made on shipbuilders and marine suppliers to serve this swiftly growing offshore oil industry.

Shipyards along the Gulf coast are making vital contributions to a solution of the marine problem. Yards like Bethlehem in Beaumont; Levingston and Consolidated in Orange; Sewart in Morgan City; Avondale, Higgins, Alexander, and Equitable in New Orleans; Ingalls and the two Walker yards in Pascagoula, Miss.; Alabama Drydock in Mobile and dozens of smaller yards are hard at work to turn out specialized marine tools.

From the giant mobile drilling platforms, costing upwards of $2,000,000, to the hundreds of small crew boats, supply vessels, submersible tanks, barges and other craft used in the offshore oil fields, the shipyards and marine suppliers and their engineers and marine architects are working closely with oil men to find the most efficient equipment for every particular need.

The transition from shallow to deep water operations has brought about a decided change in design of floating equipment. The luggers, small tugs and barges and crew boats used in the marshes and shallow water fields along the Gulf of Mexico are wholly inadequate to meet the needs of deep water operations.

Currently the shipyards are in a race to develop a suitable supply vessel that will serve the offshore rigs. Mechanical Equipment Co. of New Orleans designed a 123-foot self-propelled barge, built by Dade Drydock Corp. of Miami, Fla., which is now under charter to Shell Oil Co., as a tender for the submersible drilling barge "Mr. Charlie." This vessel, the "Pelican Driller," was adapted after the style of the wartime LCT, with machinery and pilot house aft.

It is powered with two Buda 516 hp marine diesel engines, and equipped with Snow-Nabstedt reverse and reduction gear, Leece-Neville air starter, Buda diesel generator sets, Westinghouse engine controls, and MECO hydraulic steering system.

The vessel can carry 350 tons of cargo with dry cargo such as pipe, mud, cement and supplies on deck and drilling water in tanks built into the hull. However, the industry is now looking for something larger in the way of a supply vessel. Mechanical Equipment is presently planning a 135-foot boat with sufficient deck space to carry two lengths of Range-3 drill pipe, as well as other materials and supplies.

The MECO design will look like the Great Lake ore carriers, with the pilot house high on the forecastle head, and the engine room aft and below the flush deck. The designers believe that a vessel of this type will carry more cargo and will lend itself to the dual purpose most supply craft are called upon to perform, that of a seagoing tug to handle the drilling tenders and deep sea barges.

MECO designers plan to power their new supply ship with twin Buda diesel engines capable of furnishing 1,000 hp. They say that while the present "Pelican Driller" provides only 65 feet of deck space out of an overall length of 123 feet, the new supply boat will afford 105 feet of deck space in 135 feet length overall.

But the MECO design is only one of several offshore boats now on the drafting boards. One type, which bears the stamp of approval of one of the major oil companies, resembles a smartly trimmed seagoing tug, with deck space for pipe and dry cargo and tanks below deck for drilling water.

As oil prospecting moves farther and farther from shore in deeper water, the need for larger vessels becomes more apparent. Probably the most important logistic factor in offshore drilling is proper timing of materials and services. Offshore rigs must at all times carry large inventories of materials, supplies, and spare parts. Some carry twice as much of these supplies as would be required to drill a well on land.

Because loading of materials is frequently delayed by weather, it is necessary to keep these large inventories on hand so that drilling operations will not be held up. By the same token, it is felt that larger, more seaworthy craft will permit greater pay loads and fewer delays in transit.

Cost of the supply vessels will range from $188,000 for a type the size and design of the "Pelican Driller" to upwards of $200,000 for the larger vessels now required by the oil companies.

The smaller and faster crew boats also have undergone a transition with the movement of operations farther seaward. Transportation of crews has always been an expensive problem. Oil field workers have to be paid for the time they are travelling from shore base to rig, not just for the time they are actually working.

High speed launches are too light and fragile for the ocean, and the heavier luggers, while safe enough at sea, are slow. Consequently, it often takes six to eight hours to get a crew to a location.

Sewart Seacraft at Morgan City, La., supplied part of the answer with its comparatively fast steel crew boats. They have sold scores of these boats, mostly 65-footers, to crew boat rental companies.

The latest to come out of the Sewart shipyard was designed by engineers of Sewart and Mechanical Equipment Co. and is powered with twin Buda 300 hp marine diesel engines. This 65-foot crew boat, which carries 30 men in the bus-type seats, can travel 22 miles an hour. It has Capito reverse and reduction gear, two to one ratio; Westinghouse air compressor, V-belt driven from the engine; Jabsco fire and bilge pump; Burgess type SDM marine spark arrestor silencer; Morse model MH-2 engine controls complete with American Chain Tru-lay control cables; and Apelco 50-watt ship-to-shore telephone. It represents a state of perfection which the builders feel has been reached after building and operating a number of such boats in actual offshore work. The vessel is complete with all facilities necessary for this service, and is fully approved by the Coast Guard to carry passengers for hire.

However, the helicopter is rapidly taking its place as a facility for crew transport, although it probably will never entirely replace the crew boat. Petroleum Helicopters, Inc., of New Orleans and Lafayette, leader in this field of transportation, is now servicing several offshore rigs in the Gulf of Mexico with its three 10-place Sikorsky S55 transport helicopters and 14 Bell helicopters, operating

from bases at Grand Isle, Empire, Lafayette, and other locations along the Gulf coast. Most of the newer tenders and all of the large mobile drilling platforms are equipped with heliports.

It takes no more than half an hour to reach even the most distant drilling rigs by helicopter as compared with many tortuous hours by surface craft.

Helicopter service is expensive. One firm pays $500 per day and $75 an hour flying time to transport its crews by "whirlibird"; but weighed against the cost of crew boat rental, cost of fuel and overtime, oil executives feel the helicopter service is worth its cost.

The problem of logistics for an oil company begins when it decides on a location at sea and begins building a drilling platform. In the early days of offshore drilling, engineers for J. Ray McDermott & Co., Inc., Houston, created a device for building platforms at sea. This was the templet, a structure of heavily braced piping, through which piling could be driven. Once the well was completed or abandoned the piling could be removed and the templet barged to another location. Templets could be built to any size, but usually their number was increased depending upon the size of the drilling platform required.

After nine years of offshore work, the McDermott templet is still regarded as the best construction for an offshore platform.

The templet, or pipe jacket, as it is more commonly known in the industry, is constructed at a shipyard and transported by barge to the drilling location. There it is lifted by crane into place, piling is driven through the pipes into the floor of the ocean and construction begins on the floor and superstructure of the platform.

A small platform, designed for six wells, will cost approximately $350,000. A self-contained platform, designed for nine wells and containing quarters for the crews, warehouses, and all the machinery necessary for drilling an oil well, will be five times as large and will cost approximately $1,500,000.

Such a structure is now nearing completion off the coast of Grand Isle for the CATC group in the deepest water yet encountered in the offshore oil fields—97 feet. Avondale Marine Ways, New Orleans, built the templets and J. Ray McDermott is erecting the platform.

Once drilling operations begin, the problems of transportation vary with the condition of the weather, the distance of the rig from shore, and the difficulty the supply craft meets in laying alongside and landing the tons of pipe, mud, cement and supplies.

Not the least of these is the task of feeding and quartering the drilling crews. Workers on offshore rigs usually work on a basis of 10 days on and five off. Usually they work 12-hour tours and their off-duty hours are spent in whatever forms of recreation the drilling platform or tender is able to provide.

The costs of caring for drilling crews in offshore locations are considered high as compared with most field operations. Factors are the relatively few people involved, the high standards required by the oil companies and drilling contractors and the great distances involved in the transportation of supplies.

Offshore personnel who must live on location range from 24 on the simple, self-contained platform and tender, to a maximum of 40 to 50 men employed on the larger tenders.

Figuring about 40 active rigs working in offshore locations at the present time, there are an estimated 1,600 men to feed, exclusive of visitors, company officials, and crews of supply boats.

Per capita costs of feeding and housekeeping will vary according to the type and condition of the rig, but a good average is $9 per man per day. This figure includes the cost of food and its preparation and servicing, as well as such housekeeping expenses as linen, paper and cleaning materials. The offshore drilling rig provides complete hotel service for its workers. As one company official expressed it: They've got everything but the bell hops."

And that means stewards to make the beds, clean the rooms, serve the meals, and licensed able-bodied seamen to perform such requirements of deck seamanship as would be found on any seagoing vessel.

About 50 percent of the offshore rigs are "company fed." That is, either the oil company or the drilling contractor does the housekeeping. On the remaining 50 percent, this service is contracted, either on a "turnkey" basis or on a cost-plus basis.

Most self-contained rigs and tenders now have air conditioned quarters and modern facilities for food storage and refrigeration so that they actually could be provisioned only about once per month. Properly planned food inventories generally make it unnecessary to bring supplies to the platforms more frequently than once per week.

Because of the large amount of work involved in unloading and stowing food, which more or less interferes with the regular routine of the drilling rig, it has been found practical to deliver food supplies to the rigs every one to two weeks.

Food supplies are usually carried along with regular deliveries of drilling materials and water. It has been found more efficient to feed "cafeteria style" as against "family style," and most offshore feeding is conducted in this manner. Emphasis is continually placed on efficiency, which means reduction of waste, never on food economy. The companies have taken the initiative in seeing that their crews are provided with the finest quality of food and plenty of it. A typical menu, for example, will consist of a soup, a main meat course and a secondary meat course, salad, several vegetables, dessert and a choice of beverages.

A great deal of attention is given to the preparation of balanced meals and trained specialists constantly study the dietary problem of the offshore rigs.

The first food contractor, and the largest, in the offshore field is General Marine Corp. of Harvey, La., whose founder and president is Wallace Taylor, a former Texas lawyer and statistician who started a boat contracting business in 1947. A little over a year ago Taylor submitted a bid to "crew" a fleet of geophysical boats. His bid contained a detailed breakdown of feeding the survey crews. He didn't get the contract, but the geophysical company asked him to take over the feeding chore. Other companies, plagued with the unwanted task of doing the housekeeping for their drilling crews, were attracted by the singular service General Marine had to offer, and a new industry was born.

Oil men who go down to the sea have many problems not encountered by their colleagues ashore. One major oil company operating in the tidelands utilizes the following contractual services:

(1) Shipyards to build the pipe jackets, or templets, for erecting the drilling platforms at sea.

(2) Machine shops to fabricate the piling.

(3) Erectors to install machinery on the platforms before they are towed to sea.

(4) Barge and towing companies.

(5) Hoisting companies for lifting jackets into place at location.

(6) Pile driving contractors, for erecting the platform.

(7) Welding contractors.

(8) Drilling contractors.

(9) Boat operators to supply crew and materials boats.

(10) Fuel oil contractors.

(11) Cathodic protection for the wells at sea.

(12) Well servicing and surveys.

(13) Oil well cementing contractors.

(14) Fishing tool contractors.

(15) Contractors for supplying private aids to navigation.

(16) Labor contractors for building pipe lines.

(17) Labor crews for laying submarine cable for electric drilling. (California Co. uses shore-produced electricity for drilling in the Bay Marchand field.)

(18) Purchase of power.

(19) Shipyards for conversion of drilling tenders and other craft.

(20) Food caterers.

It can readily be seen that the coordination of all these services calls for the most careful "logistic" planning.

Exploratory activity widespread

THE YEAR 1954 was one of activity in exploration for petroleum in all parts of the world. In the United States the total number of wells drilled was 53,918 and the total footage was 218,950,000 feet. These figures compare with 49,275 wells and 198,740,000 feet drilled in 1953. Of the completions, 29,770 were oil wells, 3,960 gas and 19,066 dry holes.

Wildcat drilling showed an increase of only about two percent in the number of wells drilled, but more than four percent in footage. Estimates for the current year are that there will be little change from 1954 in development drilling, but a probable increase of 10 percent or more in exploratory work.

Elsewhere there was a substantial gain in survey work and in test drilling. Progress along this line in Venezuela, which was the most active field in South America, is described in other pages of this issue.

In Europe, circumstances have combined to stimulate an unusual amount of active exploration. The success of the Esso organization in finding substantial production in its first Parentis drilling has led to a rush of applications for concessions covering practically all of the continental area of France and to a systematic campaign of test drilling in the area covered by the license to the Esso group. Opening of new fields and extensions in Germany has led to the sinking of a number of deep tests and a substantial addition to production. Discoveries in Sicily by Gulf and D'Arcy Exploration companies have renewed confidence in the finding of worthwhile deposits further north.

This confidence was strongly reinforced by the finding of commercial production early in 1955 in the Cigno No. 1 well, drilled by Petrosud (a joint partnership between Gulf Oil Co. and the Italian chemical company Montecatini) at Alanno, province of Pescara, in central Italy. The region surrounding Alanno, as well as other areas in the Abruzzi region a few miles from the Adriatic coast, was explored before the war, but abandoned as unproductive.

Petrosud started exploratory work in the Abruzzi region, where superficial indications of oil have been known since ancient times, and where asphaltic bitumens were being industrially exploited during 1953. The area has been again surveyed for Petrosud, using the most recent geologic and geophysical methods, by the Compagnie Generale de Geophysique and Western Geophysical Co., and drilling was started in October 1954. Cigno No. 1, the first well drilled, hit oil at 2,300 feet. Production tests showed a flowing average daily production of 2,800-3,000 barrels of 39° API crude. A second test is presently being drilled.

Petrosud has applied for an exploitation concession, which, under the Italian mining law, is independent of the exploration concession. Crude probably will be processed at the Falconara (Ancona) refinery of Azienda Petroli Italiana, an independent refining and marketing company.

Revision of Turkey's petroleum law to permit private capital to join in the search for oil has led half a dozen international companies to file applications for exploratory permits.

Even in Great Britain, where the search for oil has been maintained for years in the face of very meagre results, some encouragement was derived last year by additional discoveries in British Petroleum's Plungar field in Leicestershire, where oil was found near the end of 1953. In October last, production was established in Well No. 6 at 2,853 feet, yielding at an initial rate of about 85 barrels per day. Well No. 7 which followed is expected to produce 35 to 40 barrels daily. The eighth well is now drilling and several other sites for tests are being made ready.

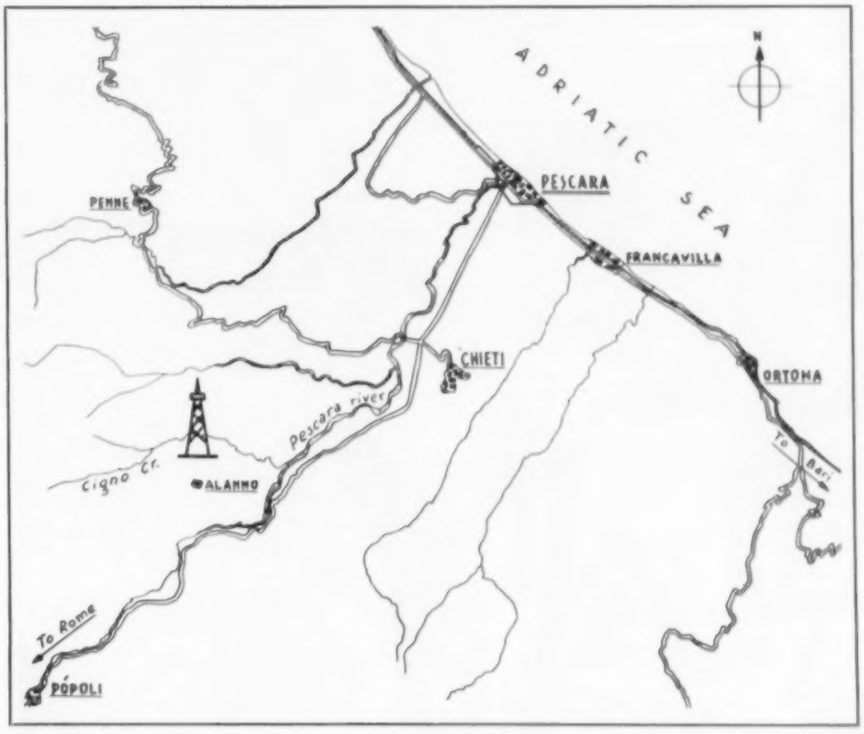
Other test wells are being drilled by British Petroleum at Faringdon in Berkshire and at Chaldon Herring in Dorset, and a seismic survey is under way in Wiltshire.

Drilling is in progress at Crowborough, Sussex in a hunt for natural gas in behalf of the Gas Council and reflection surveys are being carried on in Sussex and Yorkshire as part of the same program.

Exploration on the African continent is being continued in Algeria and Tunisia, where it has been under way for several years, and has been extended to the French Sahara, to western Egypt and to former Italian Somaliland.

In East Africa, where British Petroleum is carrying on exploration in association with the Royal Dutch/Shell group, a gravity survey of Zanzibar was con-

Start of drilling on deep test of D'Arcy Shell Petroleum Development Co. on Mafia Island off east coast of Africa. Picture shows, left to right, Lt.-Col. Leahy; Basil Eager, managing director of the company; Sir Edward Twining, governor of Tanganyika; Mr. MacGlip and Mr. Martin. The drilling rig has a depth capacity of 12,000 feet.



Map showing location of the commercial find made by Petrosud (Gulf and Montecatini) in central Italy.

ducted during 1954 and a seismic survey is now in progress.

On December 17 the first well to be drilled on Mafia Island off the coast of Tanganyika was officially spudded in at a brief ceremony conducted by the Governor, Sir Edward Twining. The Mafia well, which may be carried to 12,000 feet, is being drilled after intensive geological and geophysical surveys since 1951 covering a wide area of eastern Africa.

Most of the companies operating in the Middle East have carried on established development programs, but intensive exploratory activities have been under way in the territory of the Iraq Petroleum Co. A new field, Jambur, was discovered. This was not unknown ground, as a drill test in 1927-29 proved unsuccessful. In 1954, however, two wells were successfully drilled in this mass of low hills and others are being drilled.

In the Bai Hassan field a fourth well was completed last year and a fifth is under way. Kor Mor has been temporarily abandoned after two wells yielded no signs of commercial production. No new wells were drilled at Kirkuk.

In the Basrah Petroleum Company's concession in southern Iraq, gravity and seismic parties surveyed a large area, and toward the end of the year structural drilling began in Luqait, out in the desert west of the Rumaila field, which began production late in December. During the year the 38th well was drilled at Zubair and a fifth well at Rumaila, where at the end of the year three other wells were still drilling.

In northern Iraq, in the Mosul Petroleum Company's concession, there was much activity in exploration, but no particularly encouraging results. Two new wells were drilled at Butmah; one gave a small production. Drilling began at Atshan and late in the year a well at Alan was re-opened.

In preparation for an intense drilling program in 1955, access roads and water supplies were made ready, in extremely difficult terrain, on the Sasan location and on Jabal Makhul. A well drilled in 1954 at Qaiyarah will maintain the annual 100,000 tons required for the government bitumen plant being erected there.

Over the whole of Iraq, during the year, gravity and magnetic parties put in 21 months, and seismic parties put in 44 months. In Qatar, four new producing wells were completed in 1954.

Elsewhere in the Persian Gulf, gravity and magnetic parties put in 12 months, and seismic parties also 12 months, in the Trucial Coast; and in Oman gravity and magnetic parties put in three months.

The latest development in the underwater search for oil off Abu Dhabi, in the Persian Gulf, is a seismic survey which began in December. The operating company, Abu Dhabi Marine Areas Ltd., is jointly owned by D'Arcy Exploration Co., prospecting subsidiary of The British Petroleum Co. (previously Anglo-Iranian Oil Co.), and Compagnie Francaise des Petroles.

This seismic survey, which is being conducted from the 405-ton ocean-going vessel "Sonic," is expected to last about four months. It follows a geological survey of the area undertaken earlier in the year by Commandant J. Y. Cousteau and his team of divers, working in conjunction with D'Arcy geologists. Samples brought up from the sea-bed have been studied at the B. P. Company's paleontological laboratory in London. Along with this examination a gravity survey was carried out.

Late in 1954 it was announced that British Petroleum had increased its stake in the oil search in Australia by the foundation of a new company, Frome Lakes Pty. Ltd., which holds licences in areas of southeast Victoria. Frome Lakes Pty, Ltd., has been formed by Frome-Broken Hill Pty. Ltd. (in which D'Arcy, subsidiaries of Consolidated Zinc Corp. and Standard Vacuum Oil Co. are shareholders), and Lakes Oil Ltd. and Austral Oil Drilling Syndicate, both Australian companies.

Drilling of a new test well in Papua by the Australasian Petroleum Co. Pty. Ltd. (in which British Petroleum is associated with Australian and American interests) is due to start shortly. The new site lies about 125 miles west of the present operations taking place at Omati where two wells are being sunk.

Omati No. 1 has successfully by-passed the bit and drill pipe which stuck when the hole caved in 1953 and has reached a depth of 13,780 feet. Omati No. 2, which was spudded in during April 1954, has reached 7,800 feet.

Student participants in the GSI Summer Co-Op program are kept busy learning by doing. The photo sequence here shows how one student, E. A. Flinn III, spent his summer with a GSI field party in the Texas Gulf Coast region. Above, left, Flinn assists in racking light casing for use in mud flat areas where cased shot holes are a necessity. The crew's quarterboat "home" is in the background.

Field training for young geophysicists

In areas too thick to drink and too thin to plow, a drill truck would be quickly mired, so Flinn helps out on a hand drill crew.

By Robert F. Alexander*

A PROGRAM designed to generate increased awareness of geophysics as a profession among university students and faculties will enter its fifth year in June under the sponsorship of Geophysical Service, Inc. of Dallas, Texas, and a number of interested colleges and universities.

The program, known as the GSI Student Cooperative Plan, was inaugurated in 1951 by GSI in collaboration with the Geology and Geophysics Department of the Massachusetts Institute of Technology. MIT students were the first principal participants and the plan was originally designated the MIT-GSI cooperative plan. Since that time, 86 students from 22 colleges and universities have participated in the plan. At MIT's suggestion the program's name was

*Geophysical Service, Inc.

changed to its more representative title in 1953.

During the summer months students are given an opportunity to participate actively in the work of a seismic crew. They are rotated among the various crew positions, from jug hustler to observer, and by the time the summer is over they are in a position to evaluate more intelligently the possibility of geophysics as a career.

Each summer session begins with an orientation conference held shortly after the close of school in June. The four-day conference is held in the auditorium at the GSI building and includes tours of various oil company research laboratories in the Dallas area.

In commenting on the aims and purposes of the summer work plan, GSI President Cecil H. Green made note of the fact that for many years there has been a shortage of personnel trained expressly for work in geophysics.

"This shortage of technical personnel," Mr. Green said, "has created competition among companies for trained graduates—competition so strong that it has become a grave obstacle to the development of the entire geophysical industry. Universities are the most important source of manpower needed to overcome this obstacle and yet many of them do not include geophysics courses in their curricula. It follows that there are many fine technically trained young men who might be guided into geophysics as a career if there were a way for them to become interested and properly informed.

"Thus, the foremost aim of the cooperative plan is to give students a chance to see geophysics at work and create an interest in geophysics as a career. Creation of this interest will open to us a greater source of manpower."

The program also promotes closer cooperation between the exploration industry and the academic world. Faculty members are invited to attend the Dallas orientation conference where they can observe industry at work and where industry members can learn of faculty problems.

The oil industry has taken an active interest in the program and its freely-given cooperation indicates the high regard it attaches to the plan and the plan's aims for contributing to the technical strength of the entire oil industry.

The four-day orientation conference is practically an education in itself. Seismic prospecting theories, office and field crew organization, instruments, equipment and specific seismic problems, including offshore operations, are but a few of the subjects discussed by representatives of GSI, cooperating oil companies and visiting faculty members.

Following the orientation conference, students are given field party assignments. The assignments are set up so that, in general, only one student is assigned to a party. This allows greater latitude in the rotation of students among field positions.

During the student's tour as a member of a seismic party, he is paid the usual starting salary rate for non-graduates and is provided with round-trip bus fare from his home to the area in which he will work. Periodic rating reports on the student's progress and adaptability to geophysical exploration work are submitted to GSI and the student's university by the individual party chiefs. These reports are examined and signed by the students prior to submission.

A final appraisal of the student is also submitted by the party chief and students are required to submit a report of their own at the end of the summer. Part of this report covers, in detail, some specific seismic problem the student has studied during the summer. Students are forewarned that in this report they will be expected to explain any phase of the summer's work. The student's impressions of the cooperative plan itself are also included in his report.

These reports form the basis for a judgment of the student's inclinations and abilities and they afford the cooperating agencies an insight into the effectiveness

The shot moment.

of the plan through the student's frank comments and suggestions.

Student participants in the program have noted "that the success of the program depends to a great extent on the enthusiasm and patience of individual party chiefs and regular crew members."

For that reason, party chiefs and crew members are carefully briefed on the program and take a genuine interest in the questions and problems of participating students.

Co-Op summer work terminates August 31 for most students. By that time students have had an opportunity to gain a well-rounded impression of office and field procedures, plus some idea of the scope of the work, its limitations and the degree of accuracy in final results.

Reports from students who have taken part in the plan indicate the time was spent with advantage to both the student and the exploration industry. Several schools are considering an arrangement whereby students who successfully complete the Co-Op program will be given academic credit for their work.

Approximately 35 percent of the students who have taken part in the plan are presently engaged in graduate study. This is understandable, in that the universities recommend their best students for participation in the plan and these students are usually encouraged to engage in research and further study after graduation.

A sizeable number of the students were of draft age and have been called into service. From 10 to 15 percent of the Co-Op students have ultimately been employed in some phase of the geophysical exploration industry. Some of the students, after a summer in geophysical work, definitely decided they weren't suited for the work or didn't show an interest in it. Inversely, this has also worked to the advantage of all concerned.

Interpretation techniques and general office procedures make up an important segment of the summer's work.

The management of GSI felt that success of the plan in the United States warranted the establishment of a similar program in Canada. Geophysical Service International Corp., GSI's Canadian affiliate, has instituted such a plan. Students are drawn principally from Universities of Toronto and British Columbia. The third annual Calgary Orientation Conference, counterpart of the Dallas Orientation Conference, was held in June 1954.

Dr. B. F. Howell of Pennsylvania State University remarked that "both (the students) and I are very happy about the experience. His viewpoint toward a geophysical career was matured much as a result of his contact with field work. It has left him convinced that geophysics is a desirable career."

One former Co-Op student, in a letter to GSI regarding his summer of work, said: "I had often heard the word 'geophysics' mentioned, but it was only after I had been given the opportunity to do the work myself that I really began to grasp the meaning of applied geophysics."

"It appears that GSI had done a very good job of introducing a relatively large group of young technical men to the geophysical industry," said W. Dow Hamm, manager of exploration for the Atlantic Refining Co.

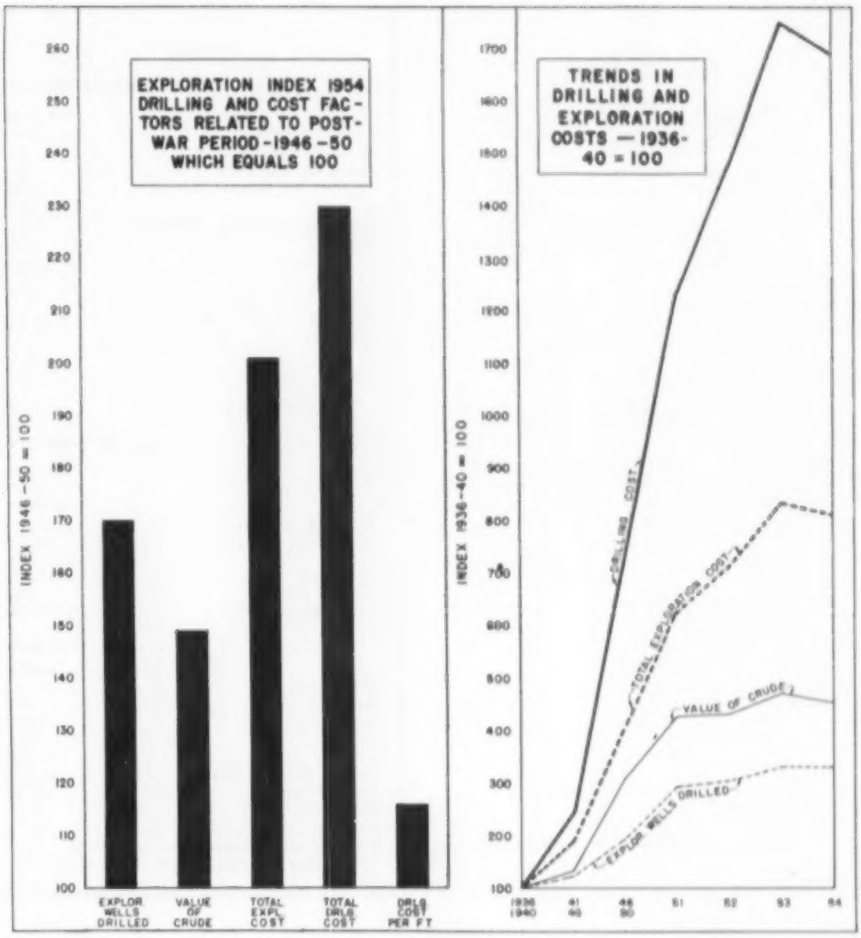
D. L. R. Wilson of the University of Massachusetts called the cooperative program "a rare opportunity to learn at first hand what geophysical work is about."

Dr. Robert R. Shrock of MIT, who, with GSI President Green, was instrumental in the inauguration of the program, reported that "we are so enthusiastic about the plan that we are encouraging all our best students to participate. Students who have participated in the past have urged us to make the same opportunities available for future classes. We know the plan is being followed with great interest by both petroleum and geophysical companies because we have received favorable comment from a number of firms in both the U. S. and Canada."

The attitude of GSI party chiefs, under whose tutelage the student spends his summer, was summed up in one final report that declared: "If I had a full crew of people like this boy I could keep my feet in the cool Pacific."

Along with experienced observers, Flinn checks the record as it comes from the developing box.

Articles on exploration and oil finding costs by H. J. Struth, who is Editor of the WORLD PETROLEUM STATISTICAL YEARBOOK, *have attracted widespread interest. The accompanying discussion is preliminary to a more detailed study of oil finding costs which will appear in an early issue of this magazine.*



Efficient practices reduced 1954 exploration costs

By H. J. Struth

AT LONG LAST the oil industry has conquered the successive annual peaks in exploratory drilling costs and these may be in a gradual glide to less dizzy heights. At any rate, the trend of exploration costs has shown an encouraging reversal by a moderate reduction in well completion and footage drilling costs during 1954.

Preliminary studies of exploration expenditures during the past year offer conclusive evidence that the industry's concerted efforts to achieve maximum efficiency and economical operating practices are beginning to pay dividends in the form of reduced costs. This is of far-reaching importance to oil consumers, since any successful effort to stem the inflationary trend of costs displayed in recent years cannot fail to benefit the consumer to some extent.

The cost of drilling an exploratory well in the United States last year was about $65,043, compared with an average cost in 1953 of $66,850. The average drilling cost per foot was $14.79, compared with an average of $15.26 during 1953. Including overhead and other pro rata charges, the total cost of an exploratory well amounted to about $106,428, compared with an average total cost in 1953 of $107,940. The total cost per foot of hole drilled, including overhead charges and equipment, averaged about $24.20, against an average of $24.64 per foot drilled in 1953.

The significance of the drop in drilling cost is not the amount, which is relatively small, but the fact that the sharp upward trend since pre-war years has been arrested. The fact remains that today's costs are still about 2½ times those of the pre-war period, while exploration expenditures are over eight times greater than they were in the years 1936-40. Last year the oil industry spent the huge sum of $2,272,768,000 for exploration, which comprised about 42.7 percent of the working interest value of all the crude oil produced in the nation during that year. This fact might well be considered by those who argue that the oil industry should not be allowed the depletion allowance of 27½ percent. The facts prove, however, that very few companies that are actively engaged in exploration and development of oil have ever received the maximum rate prescribed by the income tax laws. As a rule, the exemption for depletion is, on the average, far less than 20 percent.

Last year the oil industry drilled a total of 52,125 wells, excluding input and service wells. This compares with 49,760 wells drilled in 1953. Including service wells, the industry drilled well over 54,000 wells in 1954, a new all-time record. Drilling footage last year, excluding service wells, aggregated 209,803,000 feet, which compares with 202,026,000

TABLE I

EXPLORATION EXPENDITURES — YEAR 1954†

Drilling Cost	No. of Wells Drilled	Average Cost Per Well	Total Cost (Thous. $)	Per-cent
Discovery Oil Wells	1,412	$107,350	151,578	6.7
Extension Oil Wells	273	94,650	25,839	1.1
Wildcat Dry Holes	9,267	77,060	714,115	31.4
Total New Fields & Extensions	10,952	81,404	891,532	39.2
Development Dry Holes	10,403	47,820	497,471	21.9
Total	21,355	65,043	1,389,003	61.1
Other Costs				
Leases, Land Dept.	21,355	25,159	542,305	23.9
Geol. & Geoph. Prosp.		10,543	227,250	10.0
Overhead Cost		5,298	114,210	5.0
Total		41,385	883,765	38.9
Grand Total	21,355	106,428	2,272,768	100.0

COST OF WILDCAT OIL PRODUCERS & DRY HOLES

	Wildcat Oil Producers	All Dry Holes Drilled	Grand Total Exploratory Wells
Drilling Cost (Thous.)	$177,417	$1,211,586	$1,389,003
Other Costs (Thous.)	73,701	810,064	883,765
Total Cost	$251,118	$2,021,650	$2,272,768
No. of Wells	1,685	19,670	21,355
Avg. Cost per Well	$149,031	$ 102,778	$ 106,428

TOTAL WELLS DRILLED IN 1954

	Wildcats	Development	Total
Oil	1,685	26,970	28,655
Gas	386	3,414	3,800
Dry	9,267	10,403‡	19,670
Total	11,338	40,787	52,125‡
Footage Drilled (Thous. Ft.)	54,252	155,551	209,803
Average Depth	4,785	3,810	4,025
Percent Dry Holes	81.7*	25.5	37.7

‡ Excludes input and service wells.
† Preliminary Estimates.
* New field wildcats: 87.5% (1 successful out of 8 wells drilled).

feet drilled in 1953. More than 44 percent of the footage drilled last year was represented by exploratory drilling. This included dry holes drilled in development of oil pools. Wildcat drilling in search for new fields and extensions to previously discovered fields comprised a total footage last year of 54,252,000, compared with 54,035,000 feet drilled in 1953. The number of wildcat wells drilled in 1954, amounting to 11,338 was slightly less than the total of 11,436 wildcats drilled in 1953, but the average depth of such wells increased from 4,725 feet in 1953 to 4,785 feet per well in 1954.

The capital risks of drilling wildcat wells in the search for new sources of oil supply are emphasized by the fact that only one successful discovery is made out of every eight wells drilled. Thus, 87.5 percent of such ventures are dry holes. Last year the average wildcat well drilled involved a total cost of at least $123,000. Since it is necessary to drill eight wells to find one wildcat producer, it is evident that the costs involved in finding one successful oil well aggregate about $984,000. Studies of wildcat drilling costs indicate that a complete producing well, including equipment and overhead costs, involved an average expenditure last year of about $149,031. Wildcat dry holes involved an average cost of about $118,000 each, including overhead and pro rata charges. Expenditures for wildcat drilling in 1954 are computed at a total of $1,348,784,000. This comprised nearly 42.4 percent of all the money spent for drilling in exploration and development during 1954. Total expenditures for all exploration and development drilling in 1954 aggregated approximately $3,179,309,000. About 60 percent of this sum, or over two billion dollars, was spent in drilling dry holes.

Greater speed in penetration of underground formations has been a highly important factor in the oil industry's efforts to stem the rising tide of costs. At today's high costs for labor and equipment, the reduction in the number of days required to complete a well, particularly when the daily cost ranges from $1,500 to $3,000 on a majority of wells drilled, is of real importance. Many companies and drilling contractors have managed to effect substantial reductions in the number of days' drilling time required to complete typical wells. The result is more hole drilled for less money. Another factor, which is gaining widespread attention, is slim-hole drilling, which has been effective in bringing about substantial savings in the cost of equipment and drilling mud. Greater efficiency and economy of operation has been made imperative by the extremely high costs that have been experienced by the industry in recent years. The success of these efforts is made apparent by the results attained last year.

While the search for new oil supply sources is being pursued with greater intensity today than ever before in the oil industry's history, the facts reveal that the success attending these efforts is decidedly less promising than in former years. While discovery results of last year's exploratory efforts are not as yet available, the facts for 1953 and prior years show conclusively that far less oil is being found per dollar spent in its search than in earlier years. For example, in 1953, the rate of discovery was in the order of 1.08 barrels per exploratory dollar, whereas in the pre-war period 1936-40, the quantity of oil discovered per exploratory dollar was in the order of 9.53 barrels. Meanwhile, costs have mounted to levels that are discouraging

TABLE II

OIL EXPLORATION COSTS IN THE UNITED STATES

	1954 ($)	1953	1952	1951	Avg. 5 Post-war Years 1946-50	Avg. 5 War Years 1941-45	Avg. 5 Pre-war Years 1936-40
Explor. Wells Drilled*	21,355	21,573	19,350	18,760	12,585	7,145	6,400
Drilling Cost (Thous.)**	$1,389,003	$1,442,150	$1,217,365	$1,018,565	$ 604,663	$ 201,366	$ 82,351
Leases, Land Dept. (Thous.)	542,305	522,994	464,500	447,020	340,204	214,698	131,619
Geol. & Geophys. (Thous.)	227,250	248,197	193,500	165,830	93,109	57,052	35,249
Overhead Cost (Thous.)	114,210	115,243	111,880	108,160	74,166	48,669	28,978
Total (Thous.)	$2,272,768	$2,328,584	$1,987,245	$1,739,575	$1,112,142	$ 521,785	$ 278,197
Avg. Cost Per Well							
Drilling**	$ 65,043	$ 66,850	$ 62,900	$ 54,300	$ 48,046	$ 28,183	$ 12,867
All Other	41,385	41,090	39,800	38,300	40,324	44,845	30,601
Total	$ 106,428	$ 107,940	$ 102,700	$ 92,600	$ 88,370	$ 73,028	$ 43,468
Footage Drilled (Thous.)	93,890	94,505	84,635	75,903	46,668	24,864	19,932
Average Depth (Ft.)	4,343	4,380	4,374	4,046	3,708	3,480	3,114
Drilling Cost Per Ft.	$ 14.79	$ 15.26	$ 14.38	$ 13.42	$ 12.96	$ 8.10	$ 4.13
Other Costs per Ft.	9.41	9.38	9.10	9.50	10.87	12.89	9.86
Total Cost per Ft.	$ 24.20	$ 24.64	$ 23.48	$ 22.92	$ 23.83	$ 20.99	$ 13.96
Value of Crude (Thous.) †	$5,329,709	$5,491,000	$5,017,600	$4,912,640	$3,579,146	$1,563,189	$1,158,607
Per cent for Explor.	42.7	42.4	39.6	35.4	31.7	33.4	24.1
Reserves Disc. (Mill. Bbl.)	(N A)	2,151	3,306	5,138	3,516	2,013	2,650
Res. Disc. per Expl. $ (Bbl.)	(N A)	1.08	1.66	2.95	3.16	3.86	9.53
Index Relative to 1936-40							
Explor. Wells Drilled	334	337	302	293	197	112	100
Value of Crude Oil †	459	474	433	424	309	135	100
Drilling Cost	1,687	1,751	1,478	1,237	734	245	100
Other Costs	451	453	393	368	259	164	100
Total Exploration Cost	817	837	714	625	400	188	100
Footage Drilled	471	474	425	381	234	125	100
Drilling Cost per Foot	358	369	348	325	314	196	100
Index Relative to 1946-50							
Explor. Wells Drilled	170	171	154	149	100	—	—
Value of Crude Oil †	149	153	140	137	100	—	—
Drilling Cost	230	238	201	168	100	—	—
Other Costs	174	175	152	142	100	—	—
Total Exploration Cost	204	209	179	156	100	—	—
Footage Drilled	201	202	181	163	100	—	—
Drilling Cost per Foot	114	118	111	104	100	—	—

‡ Preliminary Estimates.
* Includes wildcat oil producers and all dry holes drilled in search for and development of production (gas wells eliminated). ** Includes cost of equipment.
† Net working interest. (N A) Not as yet available.

to the investment of risk capital. In fact, if it were not for the depletion allowance, it would be difficult indeed to attract private capital to explore for oil and gas.

Early estimates indicate that the production of crude oil in the United States during 1954 aggregated about 2,208,000,000 barrels. This compares with the production in 1953 of 2,359,998,000 barrels. The drop in crude output was made necessary last year by an unanticipated decline in consumption of petroleum products. This was primarily influenced by an unusually warm winter season, accompanied by a further decline in the volume of export trade.

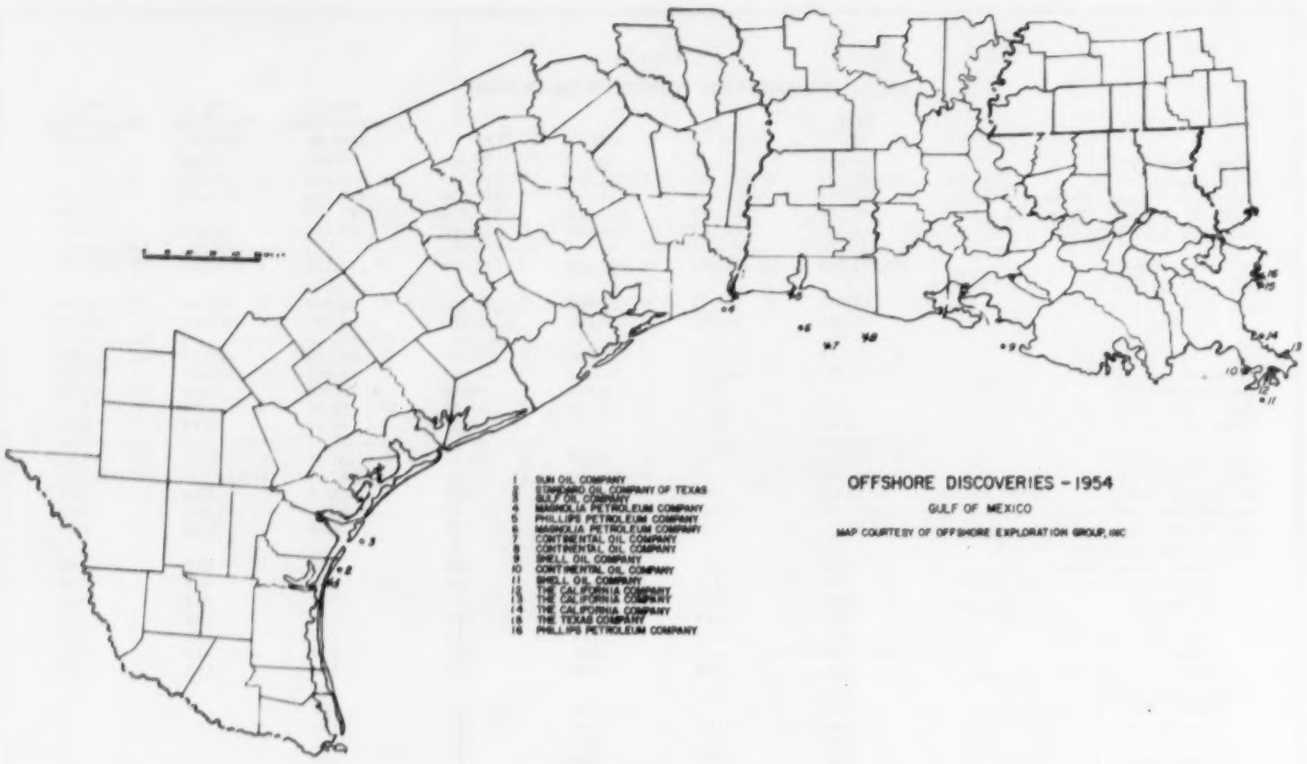
At an average price of $2.82 per barrel, last year's crude output was valued at $6,226,560,000. After the payment of royalty interests, the net value of producers amounted to $5,323,708,800. This represented a decline from 1953 of about $184,881,000. In this connection, it is of interest to landowners and holders of royalty interests to see that their share of the nation's crude oil output last year amounted to $902,852,000. This equalled 14.5 percent of the total value of all the oil produced in 1954. This was exclusive of yearly rentals and bonuses paid to landowners. The combined total of $1,444,852,000 definitely represents income from an "extra crop" to the nation's farm and ranch owners.

The breakdown of the exploratory oil dollar indicates that 61.1 per cent of the country's expenditures in 1954 went for direct drilling costs, while 38.9 percent was incurred by other charges and overhead. In 1953, the proportions were 61.9 percent for drilling and 38.1 percent for other charges. Leasing costs were greater in 1954, due to competitive leasing activities and the payment of higher rentals and bonuses to landowners. Estimates indicate that the oil industry now has under lease throughout the United States a total of 235,785,000 acres of prospective oil lands. It is apparent that expenditures for geological and geophysical prospecting were reduced by some $20 million, while overhead costs showed practically no change from the preceding year.

While the report of the Petroleum Reserves Committee of the API and AGA is not yet available to the industry, it is believed that the findings of the committee will make a somewhat better showing for 1954 than was reported for 1953. Initial reserves discoveries in 1953 were reported at a total of 4,040,099,000 barrels, including revisions of previous estimates. Indications at this time point to the likelihood that new reserves discoveries and revisions in 1954 may prove to be in the neighborhood of some 4.3 billion barrels.

Numerous important discoveries were made in 1954, which are expected to add substantially to the nation's future underground supply. If this presumption is reasonably correct, it is likely that the initial cost of finding oil will also show a favorable reduction from 1953. The initial finding cost of oil in 1953 was about $1.08 per barrel. If discoveries in 1954 are anywhere near the writer's estimate, it is likely that the initial finding cost will drop to about 85 to 90 cents per barrel.

The reversal in the upward trend of costs in the petroleum industry is definitely a tribute to the advancement of science and research in the petroleum industry, and another mark of progress in the forward march of management of the companies whose efforts are devoted to serving the best interests of the public and the nation.


1 SUN OIL COMPANY
2 STANDARD OIL COMPANY OF TEXAS
3 GULF OIL COMPANY
4 MAGNOLIA PETROLEUM COMPANY
5 PHILLIPS PETROLEUM COMPANY
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7 CONTINENTAL OIL COMPANY
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9 SHELL OIL COMPANY
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11 SHELL OIL COMPANY
12 THE CALIFORNIA COMPANY
13 THE CALIFORNIA COMPANY
14 THE CALIFORNIA COMPANY
15 THE TEXAS COMPANY
16 PHILLIPS PETROLEUM COMPANY
OFFSHORE DISCOVERIES - 1954
GULF OF MEXICO
MAP COURTESY OF OFFSHORE EXPLORATION GROUP, INC

Offshore search for oil

By Edgar R. Locke

Edgar R. Locke, vice president and general manager of the Offshore Exploration Group, is a graduate of Colorado School of Mines with twenty-two years' experience in the exploration field. Sixteen years were spent in the geophysical division of The Texas Co. where, as party chief and supervisor, he covered much of the Texas-Louisiana Gulf coastal area. For five years he was manager of exploration for Mid-Continent Petroleum Corp. He joined Offshore in 1953.

THAT GREAT GIANT of future Gulf Coast oil and gas potentiality, namely the offshore and continental shelf region, shows unmistakeable signs of stirring himself with definite purpose.

Much has been written and said about this last great oil frontier with billions of barrels of potential reserves. It therefore seems appropriate to note the obvious signs which point clearly to the purposeful movement now taking place, one which promises eventual oil and gas production in quantities comparable to present Gulf coast output.

As has been predicted, geophysical exploration in 1954 showed a very marked increase over the previous years and at year's end was continuing at a high level.

In this program the vast majority of the work done was in the areas inside of the 70 to 80 foot water depth line, although work by a few companies extended out to distances as great as 100 to 125 miles offshore and to comparable depths.

The rapid growth of exploratory activity in this region is indicated by the number of geophysical crew months for the past three years. For 1952 the number of crew months was 75, for 1953 the number rose to 196 and for 1954 it was 358.

For geophysical exploration alone, this represents an expenditure of some $26,000,000 for the year 1954.

There were no significant developments in offshore shooting technique, and consequently no appreciable increase in operating efficiency. Some refinements in design of cable equipment, camera design and improvements in electronic surveying have resulted in smoother and more trouble free operation. The first important advance in interpretation technique which will improve the quality and eventually the speed of interpretation was the introduction of the Reynolds cross sectional machine. Its application to offshore work will enable a much quicker and more thorough analysis of data obtained. This method has only been briefly tried so far, but appears to hold more promise for application to marine exploration than to land work.

Meanwhile, leasing and development showed significant increases during the year 1954. Leasing off the Louisiana coast, with several state sales near the coast and one large sale of federal leases on land outside the three league limit, resulted in an expenditure of some $135,000,000, while leasing of Federal acreage off the Texas coast added another $23,000,000 for a total of over $158,000,000. When it is realized that in all the years previous to 1954 a total of only $65,000,000 had been spent on offshore leasing, it is apparent that competition for the potential reserves offered in this new oil province is tremendous and the opportunities are also tremendous.

Prices paid at some of these sales also show the favor with which some of the areas of interest outlined by geophysical surveys are looked upon. For example, in Louisiana, the average price for acreage purchased in 1954 in the offshore sales was approximately $318 on a total purchase of some 456,512 acres leased. In prior years the average price per acre came to only about $10 per acre. The top price for offshore acreage in Louisiana was $1,220 per acre, and in all there were six tracts on which prices of over $1,000 per acre were paid. Meanwhile, in Texas a sale of federal acreage was made on November 9, at which 19 tracts totaling 67,148 acres were leased at an average cost per acre of approximately $345. Another price record fell at this sale when Magnolia Petroleum Co. paid $2,209 per acre for 1,440 acres, and seven tracts

The Wildcat, one of the boats of all-steel construction used by Offshore Exploration Group in Gulf geophysical work.

becomes key activity

brought prices of over $1,000 per acre.

From the above figures it becomes apparent that active search for oil in the Gulf is in full swing, and from this we may draw some conclusions:

(1) The considered analyses of the exploration and engineering experts of the industry and their management, indicate that the producing potential of the offshore areas justifies the payment of high acreage bonuses for these leases.

(2) The engineering problems relating to marine drilling operations are sufficiently well solved to permit operations in water depths up to 120 feet.

(3) Seismic methods and surveying techniques, when properly carried out and with surveying checks, are sufficiently accurate to allow confidence in bidding for acreage. At the prices now prevailing, however, it is apparent that the highest quality data are needed in sufficient detail to give definite outline and location of the most favorable structural areas. The era of the loose reconnaissance program giving only broad structural outlines and of questionable surveying before acquiring leases is gone.

Drilling off the Louisiana coast was more active and results most favorable during the past year. Some 43 wildcats were drilled, resulting in the discovery of seven oil fields and six gas or distillate fields. Multiple sands in some of these discoveries indicate major reserves. Development wells also more than doubled from the previous year. In all, nearly three times as many wells were drilled offshore in Louisiana in 1954 as in 1953. At year's end some 48 wells were listed as drilling off Louisiana's coast, of which 11 were wildcats and 37 development wells.

This activity will rapidly increase production, which now amounts to some 40,000 barrels per day.

Development off the Texas coast so far has been slower in starting. However, during 1954 six wildcats were completed and four more were drilling, but had not been finished when the year ended. The first oil production in the Texas tidelands came with the Standard of Texas well in the Quail field off Kleberg County, which was completed for 348 barrels per day from Frio sand at 7,760 feet. Two more wells have been completed in this field. The other discovery by Sun Oil Co., also off Kleberg County, was drilled from a surface location on Padre Island. It was completed as a dry gas well, from Frio sands at 9,112 feet. Thus, two discoveries were made out of six wildcats completed during the year and it is reported that two of the four wildcats now drilling probably will be discoveries. One of them is the Gulf well now drilling off the coast of Nueces County which has set casing to 11,704 feet in lower Frio. The other is the Magnolia well southwest of Sabine Pass, off Jefferson County, where commercial shows are reported in Miocene sands.

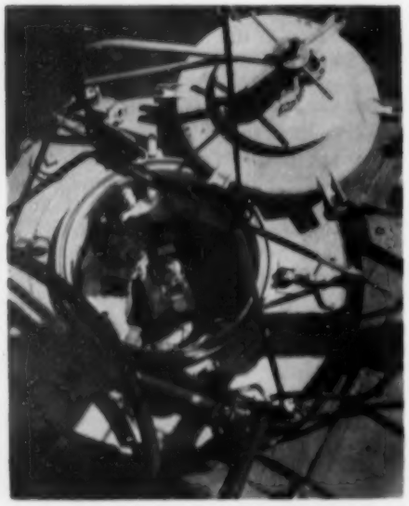
From this it will be seen that the discovery rate off the Texas coast is beginning to approach that of Louisiana, although the production potential has not as yet been so encouraging. It would seem however, that with a discovery success as encouraging as that of the past year, it is safe to look forward to continuing intensive exploration. This should lead to development of reserves comparable to those that have been obtained on adjacent land areas.

So the Giant is stirring, and as development proceeds with wells drilling in water depths up to 100 feet or more, exploration into the deeper waters must be projected, and further and more detailed coverage of the presently explored areas will be required. This is particularly true as the more prominent salt dome structures have been largely mapped and the search for the less prominent, but equally important interdomal anomalies and faulted anticlines or salt ridges that will need to be mapped in more detail become the objective of offshore mapping.

The "Beverly Ann" has been equipped by Tidelands Exploration Co. with a remote-controlled underwater gravity meter for inland and near-shore operations.

You never really know until you drill

By James W. Calvert



Newer and more efficient methods and equipment for over-water oil exploration have largely replaced gear such as this two-ton diving chamber.

THE GRAVITY METER crew was working off the coast of Texas, using a diving bell suspended from an "A" frame on the stern of an 85-foot air-sea rescue crash boat.

Inside the conical-shaped diving bell was an ex-paratrooper, just back from the Pacific theater of war, on his first civilian job—a nice, easy, safe job! All he had to do was sit on the bottom of the ocean and take the readings from a little gadget that registered the pull of gravity. After all, the ex-paratrooper had a couple of rows of battle stars to his credit, plus the Purple Heart, and the rather dubious honor of having once been given up for dead.

"We'd anchor the boat and lower the diving bell, leaving enough slack in the line so that the motion of the boat riding the swells wouldn't disturb the bell," recalls John F. Boyd of New Orleans, district supervisor for Tidelands Exploration Co., one of the many contract geophysical firms that for some ten years now have been blasting through the coastal waters of the Gulf of Mexico, supplying the sub-surface geological data upon which millions are being spent in the incredible submerged oil fields off the shores of Louisiana and Texas.

"On one particular day, back in 1945," reminisced Boyd, "too much slack had been left in the line, with the result that it had coiled around the wheel which opened the escape hatch on the top of the diving bell.

"While the crew were trying to uncoil the line and bring the diving bell to the surface, a summer squall hit with the suddenness that is typical of the Gulf of Mexico. To make matters worse, the cable jumped the block on the "A" frame and I sent a man aloft to knock the pin out of the block.

"I was talking by phone to the man in the diving bell; he asked me to tell him the truth.

"'I can take anything, just so long as I know the truth,' he told me. Well, by this time the cable was riding over

a piece of angle iron on the A-frame when the anchors began to drag. The diving bell turned over and was lying on its side on the bottom and there we went, boat and anchors and diving bell and all, dragging across the Gulf of Mexico.

"It took us an hour or more to get the diving bell back aboard. The cable was practically frayed in two from riding over the angle iron. How the wheel on the diving bell held up its weight I'll never know.

"The only calm man aboard that day was the diver. He went below for a cup of coffee and then dropped off to sleep like a baby. About an hour later he came back up and said he was ready to go again."

An incident like the foregoing would be impossible today. Gravity meter work in the Gulf of Mexico is accomplished by instruments operated by remote control. But the bulk of the geological data is supplied by geophysicists who daily set off tons of dynamite to record the reflected and refracted energy waves and thus explore subsurface formations.

The geological formations characteristic of the Gulf coast region, both onshore and offshore, were caused by the retreat of the sea in what geologists know as the Tertiary Age. Offshore the exploration involves the constant correlation of electric logs and other scientific information. The oil companies rely principally on the use of the gravity meter and reflection seismograph to give them the answers to geophysical questions.

The first step taken in developing a field is to obtain a reconnaissance report. This is studied by the geologists and, if it is determined that the area has possibilities, the company sends back for more detailed information.

Usually a minimum of two years is consumed between the first survey and the actual acquiring of an offshore lease; sometimes even more. Some companies that have been operating in the Gulf since the beginning of offshore drilling have areas that have been explored geologically time and again and are still eyed with the possibility of some day being leased.

Geophysical exploration is a continuous operation. An oil company may have detailed information about a particular area, but subsequent developments in adjacent areas may question the accuracy of the original information.

So back they will go for more, setting off charge after charge of dynamite, until the geologists are again satisfied with the data they have in hand.

There are generally two types of geophysical operation in the Gulf area. Those working in shallow water, up to depths of 20 to 25 feet, have the more complicated job. Here the operation resembles the typical land geophysical exploration except that it is performed in water and the equipment, necessarily, is afloat.

A 48-foot drilling barge is towed from one location to another, working a day or so behind the surveys. In the Gulf tidelands a drilling barge operating in fairly protected waters can drill a hole 100 to 200 feet deep in about a quarter of an hour. Tidelands Exploration crews have frequently drilled as many as 33 holes in a working day.

The dynamite is usually set from a lugger-type boat while the recording units use 45-foot speed boats to lay the marine cable and set geophones.

In surveying the tidelands areas it is generally possible to make sight observations, since the operations are mostly within sight of land. The surveyor will set his transit on a portable aluminum tower which is lowered into the water, sometimes as deep as 18 feet, starting his observation from a Geodetic Survey triangulation benchmark. He will mark the shot points with buoys or with reeds stuck into the mud.

The crew of 20 men lives on a quarter boat, anchored as near to the scene of operations as water and weather will permit. A typical geophysical crew consists of a party chief, computers, observer and his helpers, drillers, shooters, surveyors and boat skippers.

Some five vessels are required in this type of operation and the job will cost the client approximately $25,000 to $30,000 a month.

Offshore geophysical operations are conducted from two sea-going boats, usually 85 to 110 feet in length, capable of remaining at sea for 10 days at a time. One of these units is a dynamite boat, which sets off charges four feet below the surface of the sea. If a charge goes off too far underwater, it will create a bubble on the surface which gives a secondary explosion and distorts the data.

The recording boat, standing about 1,000 feet away from the explosion, tows a marine cable and the geophones which pick up the vibrations and transmit them to instruments aboard the boat. Seismogram photos are developed at sea and the data transmitted to the land-based party chief. Navigation and surveying at sea must be done electronically. There is a vast difference between navigating a vessel at sea and finding a geophysical shot point or a drilling location.

In radio navigation a "fix" within a mile or so is considered satisfactory. This order of accuracy is not sufficient for electronic surveying, however.

As geophysical work in petroleum development progressed farther offshore, a need arose for a surveying method which would have a greater range than methods previously developed for navigational purposes. This need has led to the adaptation of hyperbolic methods for long-range radio location work.

The hyperbolic methods generally available for electronic surveying are Raydist, Lorac and Decca, all trade names. The three methods are based upon the principle of measuring the phase difference between radio signals received from two transmitters, located at known positions.

The newest development to come into the offshore oil picture is a gadget called the "Zero Header," produced by Seismograph Service Corp. of Tulsa. The Zero Header, which resembles a television tube, enables the layman to move directly from one point to another on the water in an absolutely straight line.

It is different from radar or sonar, or any type of obstacle indication device, in that the "header" provides continuous data on the progress of a ship moving from one point to another in relationship to fixed, pre-determined points.

These points are available from the Lorac network on the Gulf coast, which consists of seven networks of 21 land-based stations from Mobile Bay to the Rio Grande River.

There are five degrees of sensitivity to the header, and it is so exact that even waves rocking the boat are reflected on the scope.

Raydist coverage consists of five networks on the Gulf Coast, with a sixth, at Brownsville, proposed for construction when requirements in that area make it economically practical.

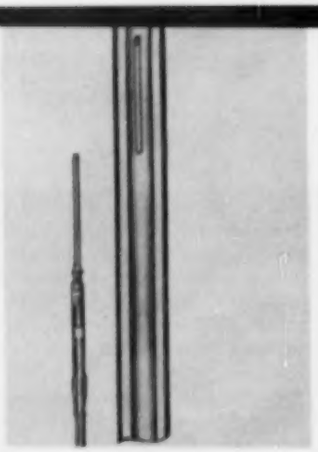
Each offshore geophysical boat must have an operator for one of the electronic navigation companies in addition to its regular crew. Each unit of two boats also must carry, as observer, a representative of the Department of Wildlife and Fisheries to see that no overcharge of dynamite is used or that a charge is not set off in a large school of fish or in an oyster bed. There is also a representative of the U. S. Corps of Engineers aboard to see that no obstructions are left standing that will be a menace to navigation.

The cost to the client for this operation will run from $60,000 to $70,000 per month, but the offshore crew can shoot as many as 300 locations in a day; hence the cost per acre is considered relatively lower than that in inland waters.

Just how many geophysical crews are working in the Gulf of Mexico has not been accurately determined. Tidelands Exploration alone has 12 to 14 crews operating in South Louisiana waters. In addition to the contracting geophysical firms, the major oil companies have their own geophysical parties covering the area.

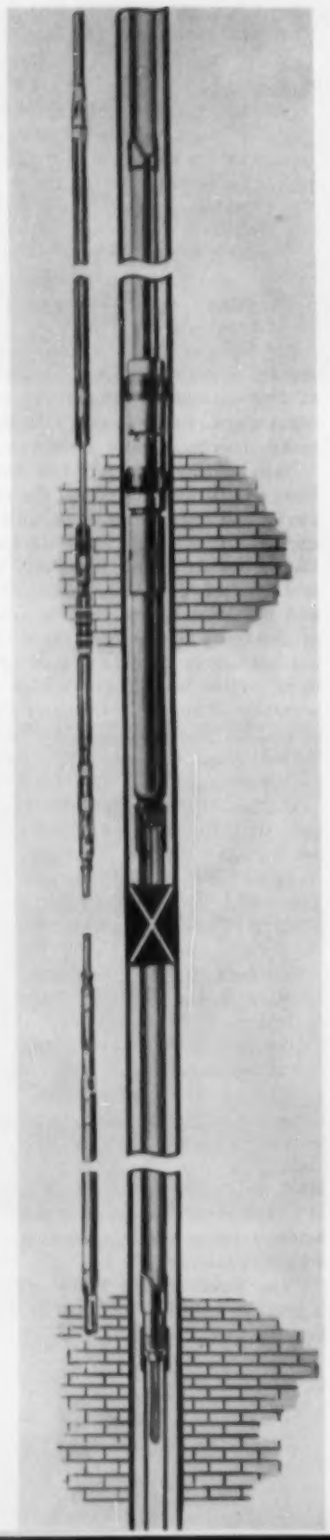
But, as California Company's divisional exploration superintendent, L. F. Adams, pointed out, geophysics is not an exact science.

"You never really know whether oil is present until you actually drill a well," he observed.



Operation and equipment of

DUALLY-COMPLETED WELLS



PRESENT-DAY methods for the practicable and profitable production of dually-completed oil or gas wells have progressed to such a degree that, as a matter of practical economics, operators are virtually compelled to review the possible advantage of two-zone production from the same well bore before embarking upon new drilling programs.

This is forcibly evident when it is considered that a second, known formation can be produced at a small percentage of the cost of drilling and completing a new well. Too, the development of another pay horizon by re-completing a single-zone well ofttimes is more desirable than re-drilling to deeper pays or drilling twin wells. Of no small consideration also is the amount of steel required under today's conditions to bring in a new well. It is estimated that approximately 85 tons of steel are required to produce the average 4,000 foot well. For example, the original bill of materials might read something like this:

Oil string	40 tons
Surface pipe	25 tons
Tubing	10 tons
Rods	3 tons
Wellhead and fittings	2 tons
Pumping unit, etc.	5 tons
Total	85 tons

These data do not take into account the amount of drilling rig steel; they only reflect the amount of steel which is actually left on location to produce the well. Approximately 226 tons of steel are required to pump an 8,000-foot well, and to produce a pay at around 12,000 feet, some 370 tons of steel are required. A dual-completion, where possible, naturally eliminates the need of additional outlay for pipe, tubing, a pumping unit, pumping engine and other capital equipment.

Figure 1

Assembly for rod pumping two zones through a single well bore. At top is upper pump assembly which is located above upper packer containing special cross-over flow conduits; the standing valve for the upper pump (tubing type); and an internal pack-off assembly seat in the lower portion of the packer. Below conventional second packer is insert (rod type) pump for lower zone which seats in regular A. P. I. shoe made up in the tubing string.

More often than not the favorable aspects of dual-zone production programs offset the sometimes-complex engineering problems and certain other unfavorable factors involved. Most unfavorable factors are usually the results of the well itself, or of certain inherent reservoir conditions, and the problems actually are circumstantial rather than malfunctions of the equipment or deficiencies in the engineering principles being employed. In most cases, a dual-completion permits a well to produce two allowables to expedite the retirement of such major expenditures as cost-of-hole, the casing, tubing, and the other producing equipment that normally would have to be paid out of one allowable. The pay-out then, for a dual completion in shallow sands, is much shorter than for single-zone wells from the same producing formation. The additional drilling capital necessary to reach a second producing horizon in deeper wells (5,000 feet and deeper) is virtually negligible when compared to the cost of drilling the well bore to bring in the primary formation. It is apparent that the savings in initial investment and equipment are greater in those fields producing from more than 5,000 feet. In fact, the consensus among many successful operators today is that it is economically impracticable to drill a single-zone well where DST's indicate more than one producing horizon on the lease.

The almost-unanimous opinion of most operators is that the advantages of dual production are directly related to the amortization of the initial development and completion costs, but that a dual well has no particular operating or producing advantages over a single-zone well (not considering, of course, the revenue from two, versus one, allowable). These advan-

tages might be summed up as follows: dual completions (a) make possible the production of areas where a single-zone well would not indicate a desirable pay-out; (b) enable operators to fulfill offset obligations without drilling additional wells; (c) allow the development of maximum production at the earliest possible date; (d) allow appreciable savings on producing certain costly off-shore locations; (e) provide both injection and producing wells where cycling or pressure maintenance operations are in effect; and (f) provide two input wells with one well bore in cycling projects where two sands are being processed simultaneously. There are probably other advantages, depending upon the well, location, lease, producing horizons and other conditions of a local nature.

Many of the so-called disadvantages of dual-production are also traced to certain local conditions, and often operators erroneously blame or charge up to dual-completion programs the expenses and producing troubles which actually would be the same that would be encountered in producing the well as a single-zone operation. It is true that workover time on two-zone wells is usually greater, but in the final analysis the cost of such well servicing would not be substantially greater than if the operations were performed in succession on two side-by-side wells.

The majority of the various oil and gas regulatory commissions require that two-zone wells be produced in such a manner as to "allow simultaneous production from two separate zones through the same well bore without commingling of fluids." When a dual operation program is contemplated, all available information should be carefully reviewed with respect to the casing program and the oil string, geological interpretation of the formations, the depth to and between the formations, the expected producing life of each zone, the completion procedure, the selection of the performating, acid treatment, and similar operations, the bottom hole pressures affecting the development of the zones, the type of fluids, and the chemical and physical characteristics of the oil. It is important to anticipate, of course, whether the fluids may be highly corrosive or contain excessive water, float sand or paraffin.

A number of the dual-completion wells in the Gulf Coast area produce from gas and gas-condensate sands, and their extreme corrosiveness causes serious damage to the internal walls of the tubing and casing. This corrosion is caused primarily by acid constituents in the water produced by gas wells; the low temperature causes a condensation of the water vapor and increases the degree of corrosion in the pipe. Such corrosion has resulted in several very costly salvaging operations. To overcome this, many operators are consistent users of an internal pipe surveying service which Otis offers operators in certain highly corrosive areas of the Texas-Louisiana Gulf coast. These surveys are extremely accurate and reliable, and from them an operator can determine if his tubing is at a danger stage and whether and how soon it will be necessary to replace the corroded joints.

The surveys are made by running in a calipering instrument which contains a set of concentric, spring-loaded feeler arms. The caliper is run on a wire line, under pressure, to the bottom of the tubing string. As the instrument is withdrawn, the feelers are released to expand against the inside wall of the tubing. As and where a corrosion pit is encountered, a rotating stylus within the calipering instrument plots the location of the pit on a special metal chart which is impervious to corrosive gas or well fluids. The depth of the deflections on the metal chart are in direct proportion to the depth of the corrosion pits. Later, the metal charts are photostated to approximately twice-size, the joints are numbered and the condition of the entire string of tubing as well as the various joints is analyzed by the company's corrosion engineers (Fig. 2). The entire record is then incorporated in a comprehensive report of the tubing corrosion survey and, with this data in convenient, easy-to-read form, an operator can check at a glance the exact internal condition of the entire tubing string or he can study each joint individually. Full shut-in well pressure is admitted to all working parts of the calipering instrument, including the stylus mechanism. This feature eliminates any frictional drag which might cause a distorted picture of the inside wall surfaces if packing glands, gaskets etc., were used to pack off the internal mechanism.

Because the casing in two-zone wells is used also as a conduit for production, an inspection method was necessary for that pipe too. Calipering instruments (Fig. 3) also are available for surveying casing from 5½ to 8⅝-inch sizes. These instruments work on the same principle as the tubing calipers and with them engineers can furnish exactly the same corrosion data.

The completion, separation and production of more than one horizon through the same well bore is a simple and practical operation. Toward this end the use of the

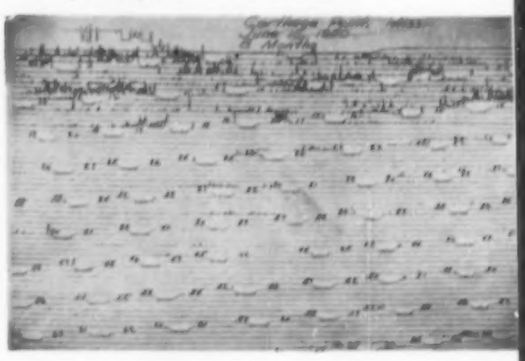
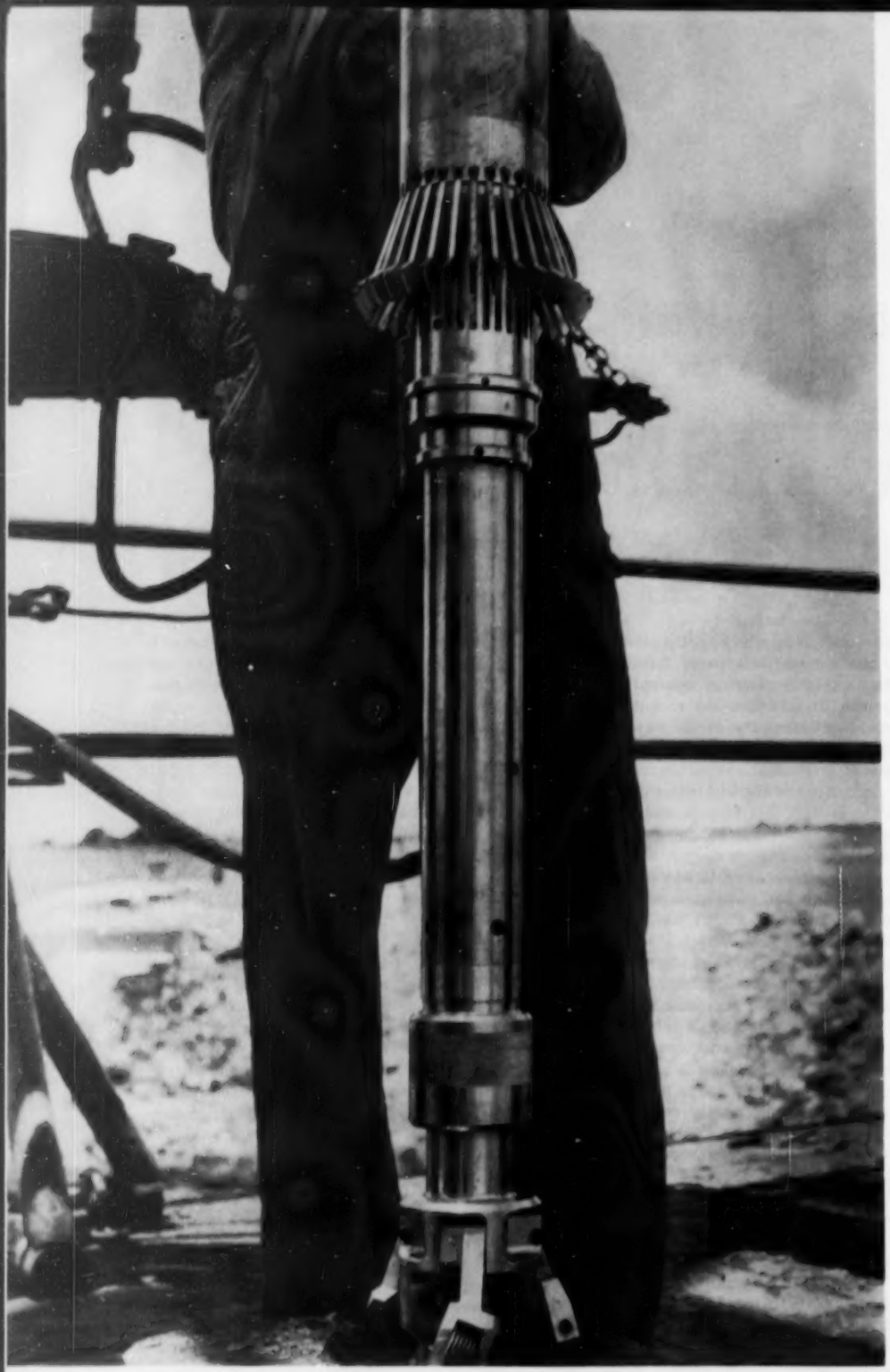
Figure 2
Corrosion damage record on a tubing string after 8 months' production. Otis caliper chart indicates that the upper 18 to 20 joints were most severely damaged.



Figure 3
Otis calipering instrument about to be lowered in the casing of a well located in a highly corrosive field in South Texas. Feelers (about mid-way on a caliper) will spread to press against inside wall of casing. As caliper is withdrawn from well, feelers will plot the location of corrosion pits on a special Otis metal chart inside the caliper. Chart is then tabulated by Otis engineers so that operator will know exact location and extent of corrosion damage on the inside of the casing.

Otis "side-door" choke (Fig. 4) and related two-zone production tools have become accepted production practices in flowing wells for a number of years. Most operators look upon this as "standard equipment for standard production programs." The principle of the Otis method for the completion and production of more than one oil or gas zone through a single well bore involves two basic steps: (1) establishing a horizontal flow course between the tubing and the tubing-casing annulus at a calculated point above the packer separating the two zones, and (2) providing a means to open or close this flow course arrangement when desired, under pressure, without killing the well, moving the tubing or disturbing the packer setting (Fig. 5), page 91.

A special landing nipple is made up as a part of the tubing string, and after the tubing, landing nipple, and packer have been run and set, and while the well is still loaded with fluid, surface connections are installed, flow lines are permanently made up and the well is cleaned up. The "side-door" choke is then run in, under pressure, on a steel measuring line and seated in the landing nipple. The choke mandrel has two sets of V-type packing rings which seal off the ports in the landing nipple.

When the choke is set, the lower zone can be brought in through the tubing and the choke bore and the upper zone through the tubing-casing annulus. When the choke is in the nipple, it is also possible to acidize the lower zone, take bottom hole pressures of the lower zone, produce the lower zone only through the tubing, produce the lower zone through the tubing and the upper zone through the casing, or take potentials of the lower zone through the tubing. With a side door choke equipped with a flow bean at the lower end of the choke bore and an orifice of desired size in the packing mandrel, the side ports in the nipple can be used to admit gas at a controlled rate from the annulus to assist the flow through the tubing. The gas can be injected into the annulus at the surface or it can come from the upper portion of the formation above the packer. The size of the flow bean and the gas injection orifice can be changed as desired simply by pulling the choke (under pressure with conventional wire line equipment and refitting it. (This method is used, of course only where the state regulatory body allows such practices.)

The Otis "flow-separation tool" is a removable choke which is used to close

the side-door landing nipple below the side ports to blank off the lower zone and connect the upper zone with the tubing through the ports. With this special tool seated in the nipple, the tubing becomes a conductor for the upper zone only and it is possible to produce that horizon through the tubing, acidize the upper zone only and take bottom hole pressures of the upper zone through the tubing.

In some cases, flowing the upper zone of a two-zone well through the tubing-casing annulus results in an unbalanced flow with excessive gas-oil ratios. For such conditions, an Otis "flow tool," which consists of a pack-off assembly made upon and run in with a macaroni string, provides a seal within the landing nipple at a point below the side ports. The macaroni string then becomes a conductor for the lower zone, and the upper zone, admitted through the side ports, is produced in the annulus between the macaroni string and the tubing. Thus the area of both flow conduits is reduced considerably to provide a more efficient flow. This also usually prolongs the flowing life of both zones.

The Otis "tubing testing tool" is a short, lightweight, solid mandrel assembly equipped with packing elements to seal the bore of the tubing above the side ports of the choke landing nipple. It can be dropped or pumped down the tubing string, and by applying pump pressure inside the tubing, the entire string above the nipple can be tested for leaks and breaks before the well is brought in. The tool is removed by reverse circulation.

An Otis "removable acidizing valve" can be run in under pressure on a steel measuring line to pack off the nipple immediately below the side ports and plug the tubing against downward flow. With this tool in the well it is possible to kill the upper zone when the lower zone will not support a column of fluid, or it can be used to prevent flow from the upper zone through the ports into the lower zone before the side-door choke is installed, or to acidize or fracture the upper zone only, or to blank off the lower zone during remedial operations for the upper zone.

Frequently in the production life of dually-completed flowing wells it is necessary to change the flow courses from the pattern originally established when the tubing and casing were installed. In some wells producing with a single, conventional packer between the formations, the upper zone sometimes ceases to flow through the tubing-casing annulus, but it would seem probable that the production could be lifted successfully through the tubing conduit. Also in some cases, operators and their engineers had anticipated that crossover style production packers were necessary to best produce the well, but discovered later that it would be advisable not to produce in the crossed-over manner, but rather to flow the lower zone through the tubing and the upper zone through the tubing-casing annulus as usual.

Normally, switching either flow course combination would necessitate killing the well and round-tripping the tubing string to change the downwell equipment. This involves considerable time and expense, of course, and there is always the possibility of damaging the producing formations with the mud or water.

Otis "selective" cross-over tools provide several distinct operating advantages and a flexibility of operation not available in other cross-over equipment, and, without exception, overcome all of the foregoing objections. Crossing over flow courses is accomplished quickly and positively simply by running in one of two types of wire line chokes which seat in an Otis cross-over nipple assembly made up on the top of the packer body. Sufficient tubing is placed between the lower and upper packer so as to position the nipple above the upper zone perforations. With the lower packer set, the tubing landed, and the surface connections made up, the upper and lower zones are brought in together. If the lower zone is to be produced through the tubing and the upper zone through the casing, a parallel flow choke is run in and locked in the cross-over nipple. If it is later desired to cross over the flow courses and produce the upper zone through the tubing and the lower zone through the casing, the regular flow choke is withdrawn and the cross-over choke is run in.

Because communication is established between the tubing and casing and consequently between the two zones when neither choke is seated in the nipple, the "selective" nipple installation affords many of the advantages previously mentioned in the description of the side-door choke equipment. Many Otis "selective" cross-over assemblies have been installed and are operating successfully in dually-completed wells in Texas, Louisiana, Oklahoma and other areas in which there are multi-zone fields.

Cross-over assemblies with special fixtures for housing tubing safety valves are often installed in two-zone wells

(Continued on page 91)

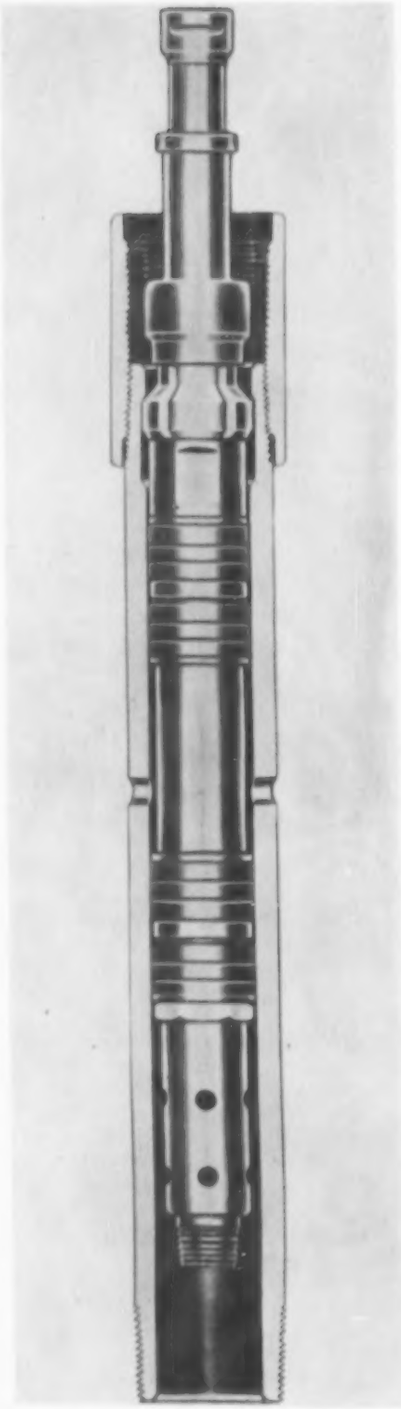
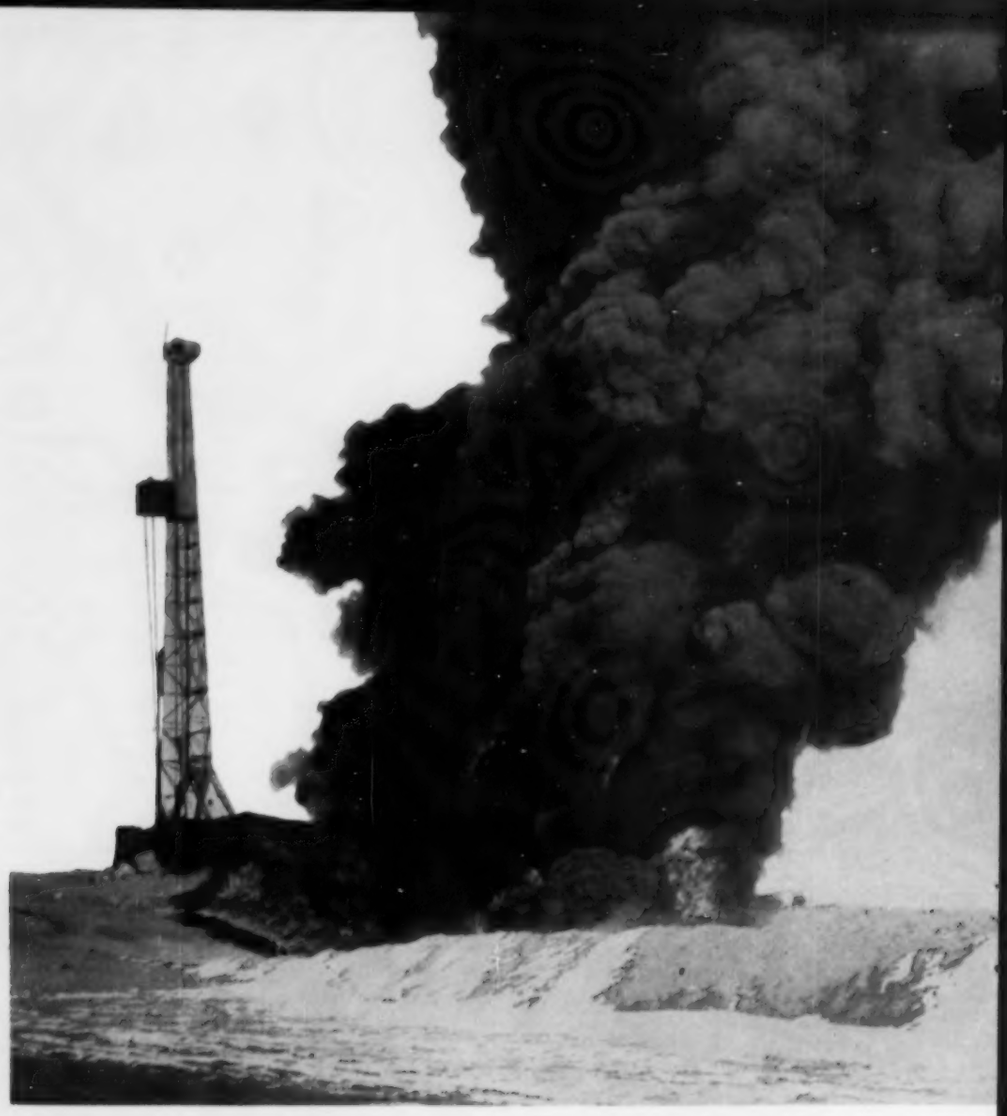


Figure 4. Otis "side-door choke" in special seating nipple which is made up between two joints of tubing above the lower pay in a two-zone well.

By Tom Dougherty
Staff writer, *Petroleum Information.*



Oil and gas is flared to pits on initial tests of 1955 discovery on the west flank of the Denver-Julesburg southwest of the city of Denver. Production was found in a new producing horizon for the basin at about 9,000 feet.

THE DENVER-JULESBURG BASIN

IN SIX YEARS the Denver-Julesburg Basin has become the focal point of oil exploration and development in the Rocky Mountain region.

During 1954, nearly 41 percent of all the drilling done in the 11-state Rocky Mountain area was done in this one basin. Colorado and western Nebraska, with very little drilling as late as 1949, became the most active in the Rockies by 1954.

In 1949 a count of oil operators and service firms located in Denver would have been a small assignment. In 1955 the city is the unquestioned administrative headquarters of the entire region. This is true in part because the Denver-Julesburg Basin has been the port of entry to the Rockies for so many operators.

The first pipe line outlet adequate to basin production was built in 1952. In less than two years there was again more oil than pipe line capacity. But in 1954 two major pipe lines offering services to both Colorado and western Nebraska were completed.

The success ratio for exploration in Denver-Julesburg is not spectacular. A lot of dry holes have been drilled. But following the discovery of two fields with productive capacity of more than 10,000 barrels per day each in the period 1951-53, the area became more and more attractive. The prospect of relatively inexpensive drilling is always a powerful incentive to exploration. The added possibility of spectacular success is all that any area needs to ensure keen and sustained interest. The Denver-Julesburg Basin has both.

The basin has a maximum north-south extent of 300 miles and is about 200 miles wide at the point of greatest breadth. It is contained within northeastern Colorado, that portion of Nebraska south and west of the Chadron Arch and the southeastern corner of Wyoming.

The deepest portion of the basin lies roughly on a line from Denver to Cheyenne. Near the Front Range of the Rockies, prominent local structural features are known. To the east the dip of the basin is gentle, less than 100 feet per mile. There are few structural features, and production is accumulated in most cases by porosity traps.

Nearly all the basin's production is from sands of Cretaceous age. The principal producing zones are the D and J sands within the Dakota group. The G sand, productive in a few scattered fields, is also included in this group. A typical wildcat will test D and J, either or both of which may have several well-developed benches.

The D sand is erratic over much of the basin. Great variations in thickness, in porosity and permeability are common. While production in the northern part of the basin from this formation is often from traps with minor structural closure, the southern area of D sand production is generally from stratigraphic traps.

The J sand is found in sections 60 to more than 200 feet in thickness. Three benches are common, with most produc-

tion from one or both of the upper benches. Saturation of as much as 80 feet of J sand section is known in some areas.

A variable shoreline, with bars, spits, lagoonal deposits and similar features is suggested in many of the fields developed in the Denver-Julesburg. Some production has been found in small folds with minor closure. Some of the better fields of the basin apparently lie in westward dipping noses, with facies changes to the east forming porosity traps.

Since discovery of oil in the Permian Lyons sand in the Black Hollow field of Weld County, Colorado, in 1953, several deeper wildcats have been drilled to test sediments older than Cretaceous. With the exception of the Black Hollow field, and small production from the Lyons in the Keota field, also in Weld County, this deeper drilling has had no success. Only a very few holes were drilled below Cretaceous in the basin before the 1953 discovery at Black Hollow.

Development of production within the basin has occurred largely over the period since 1949, but the second oldest oil field in the nation is still producing on the southwest edge. Oil was discovered at Florence in Fremont County, Colorado in 1862, three years after the nation's first commercial well was drilled in Pennsylvania.

In 1902 oil was discovered near Boulder, and in the Fort Collins area further north in 1923. These discoveries resulted in continued erratic exploration to the east, but there was no success until the Greasewood pool was found in Weld County in 1930. Development of this pool was not encouraging and the dry holes drilled in other parts of the basin during the following 19 years inspired no confidence.

The modern history of the development of the basin began in 1949. Ohio Oil drilled a wildcat on a seismograph survey high in Cheyenne County, Nebraska, in that year. The well was a Gurley pool opener. At its completion, more serious exploration began throughout the basin. During the year following the Gurley discovery more pools were found in western Nebraska and in northeastern Colorado and the number of active operators rapidly increased.

During 1949 only 39 wells were drilled in the basin in both Colorado and Nebraska. In 1950 the total climbed to 141 completed wells. Last year 1,708 wells were drilled in the Denver-Julesburg basin portion of the two states.

Production has developed mainly along a northeast-southwest trend from the Nebraska Panhandle to Adams and Washington Counties in Colorado.

During early 1955 a wildcat in Elbert County, Colorado, showed promise of production 30 miles southwest of previous trend limits. Another wildcat on the west flank of the basin, southwest of Denver, is also an apparent discovery.

This has been the course of development in the basin with a continuing series of wildcats stepping well beyond productive limits. Success in such a well brings an immediate flurry of localized activity to fill the gaps.

After the 1949 discovery at Gurley, a rush of leasing began throughout the basin. Within a relatively short time most of the acreage available was under lease. In the early days of this play a bonus of 25 cents per acre was common. Today prices in the active area are in the $10 to $25 per acre bracket. Very little acreage is still open in concentrated producing areas.

Operators of all types are represented in leasing and a substantial portion of Denver-Julesburg Basin acreage is under lease to major companies.

The desire of large leaseholders for evaluation by the drill and the eagerness of smaller operators to acquire "deals" within the basin is responsible for the wide scale system of farmouts which accounts for much of the drilling now done. Both large and small blocks have been handled under farmouts, and usually a contribution system. Farmouts from one major company to another are common, as are small block deals to independent operators.

A majority of locations made in the basin now are on seismic data. Geophysical exploration in the basin rose from about 93 crew months in 1949 to a peak of more than 400 crew months in 1951. Since that time it has declined, with 1954 activity estimated at 240 crew months.

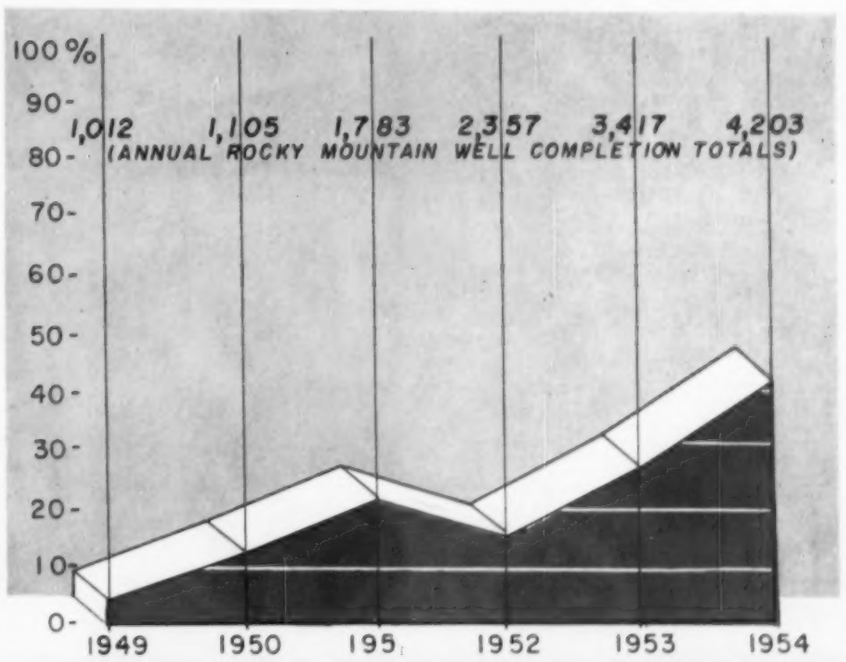
Following the Gurley discovery there was additional drilling in Nebraska, principally in Cheyenne County. Development spread to Colorado, into Logan County, which was for several years the major center of development in the basin. Discovery and development of Yenter, Walker, Mount Hope and Merino fields, among others, was the principal Logan County activity.

Extensive drilling in this rather centralized area of the basin made Sterling the most active oil town and the point of early field control for operations in northeastern Colorado.

Supply and service companies and field offices of various operators were set up in Sterling. In western Nebraska a similar, but not as extensive, development was true of the towns of Kimball and Sidney. The latter became headquarters of Ohio Oil Co., which now maintains district offices there. Kimball has had a more recent development as exploration and development increases.

The superimposition of an oil field economy upon towns previously acting as trade centers for agricultural areas made a visible difference through the entire northeastern portion of Colorado and the Nebraska Panhandle.

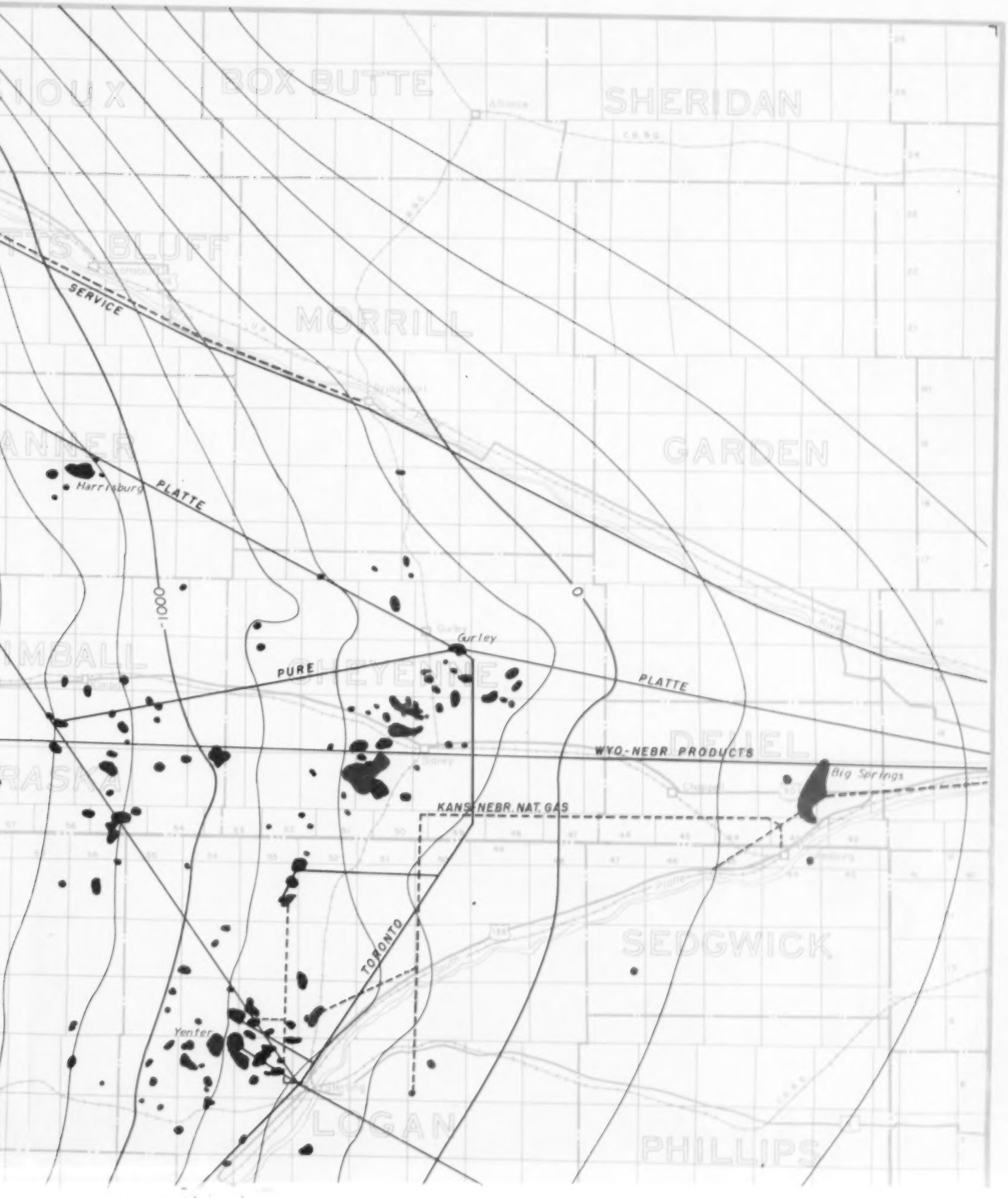
In addition to established operators

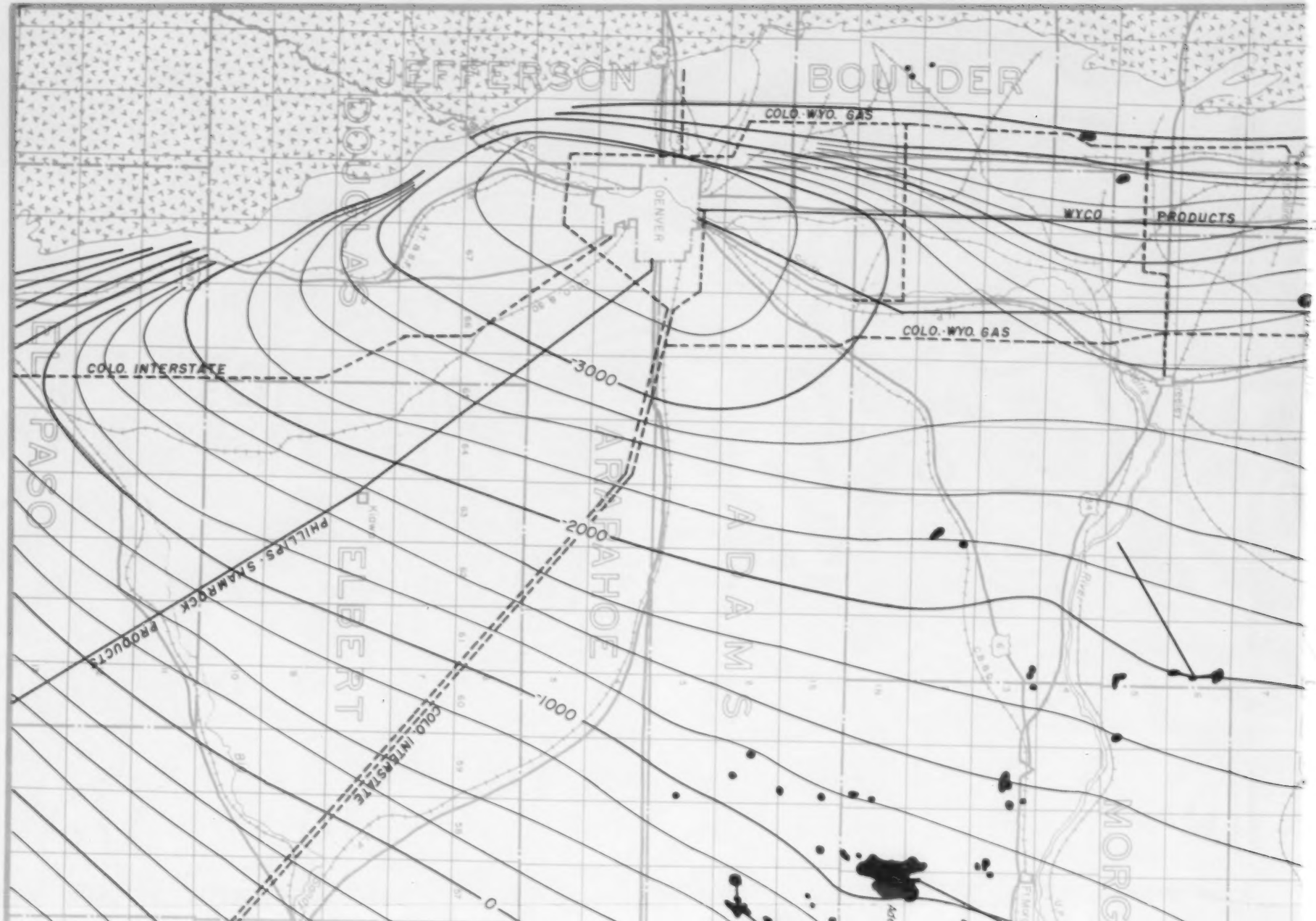


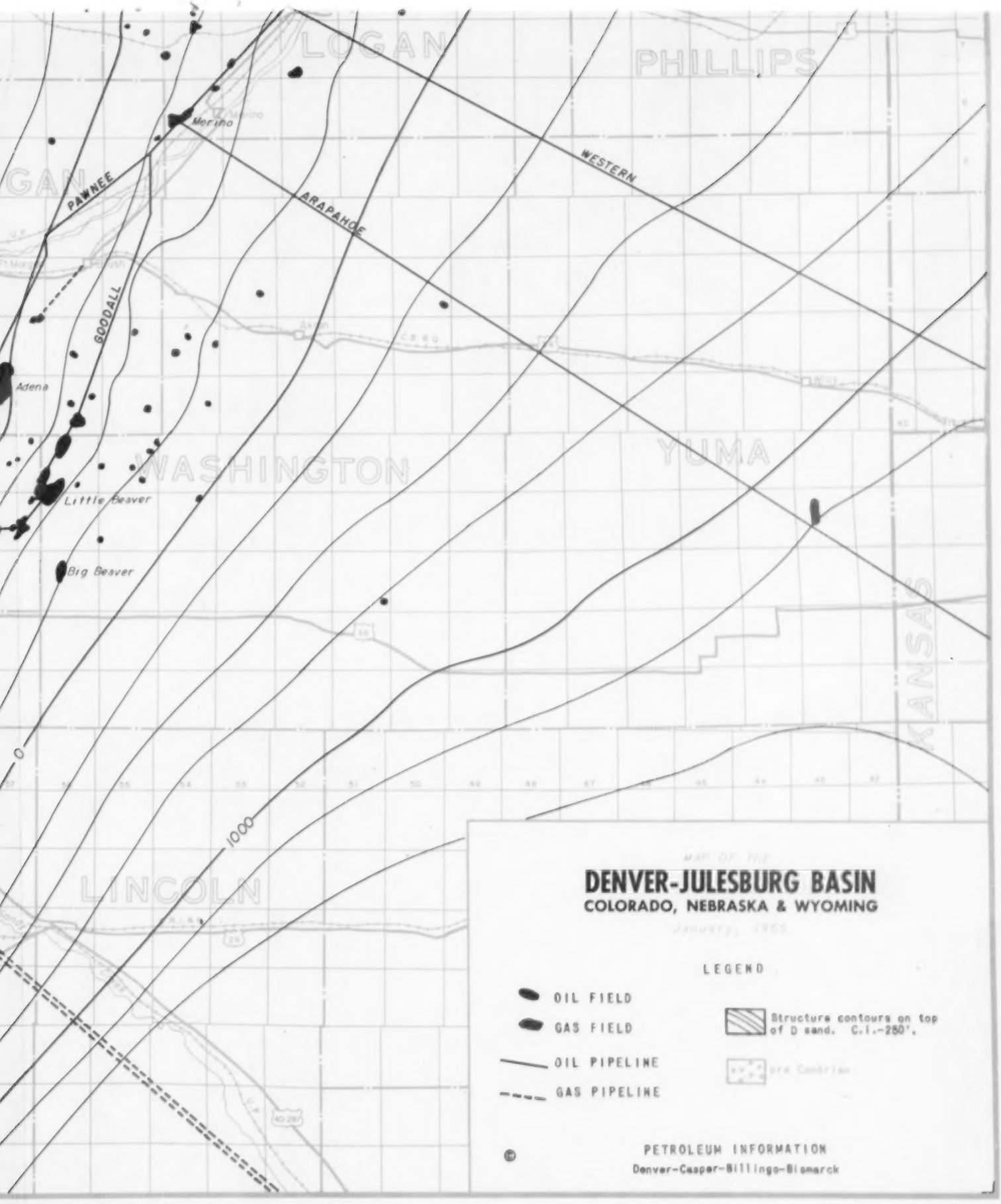
PERCENTAGE OF TOTAL ROCKY MOUNTAIN DRILLING DONE IN DENVER-JULESBURG BASIN BY YEARS 1949-1954

←OPEN UP FOR MAP OF DENVER-JULESBURG BASIN

UTAH
NO. CENTRAL GAS CO.
PLATTE
GOSHEN
ROCKY MTN.
WESTERN
-3000
-2000
LARAMIE
Cheyenne
WYOMING
COLORADO
LARIMER
Keota
Black Hollow
WELD
PRODUCTS


SERVICE
Harrisburg
PLATTE
1000
Curley
PURE
PLATTE
WYO-NEBR. PRODUCTS
Big Springs
KANS-NEBR. NAT. GAS
TORONTO
Yenter
SHERIDAN
MORRILL
GARDEN
SEDGWICK
PHILLIPS


JEFFERSON
BOULDER
COLO. WYO. GAS
WYCO
PRODUCTS
COLO. WYO. GAS
COLO. INTERSTATE
3000
2000
1000
0
PHILLIPS, S. KAMARCK
PRODUCTS
COLO. INTERSTATE
EL PASO
ELBERT
ARAPAHOE
ADAMS
MORGAN



DENVER-JULESBURG BASIN

COLORADO, NEBRASKA & WYOMING

LEGEND

- OIL FIELD
- GAS FIELD
- OIL PIPELINE
- GAS PIPELINE

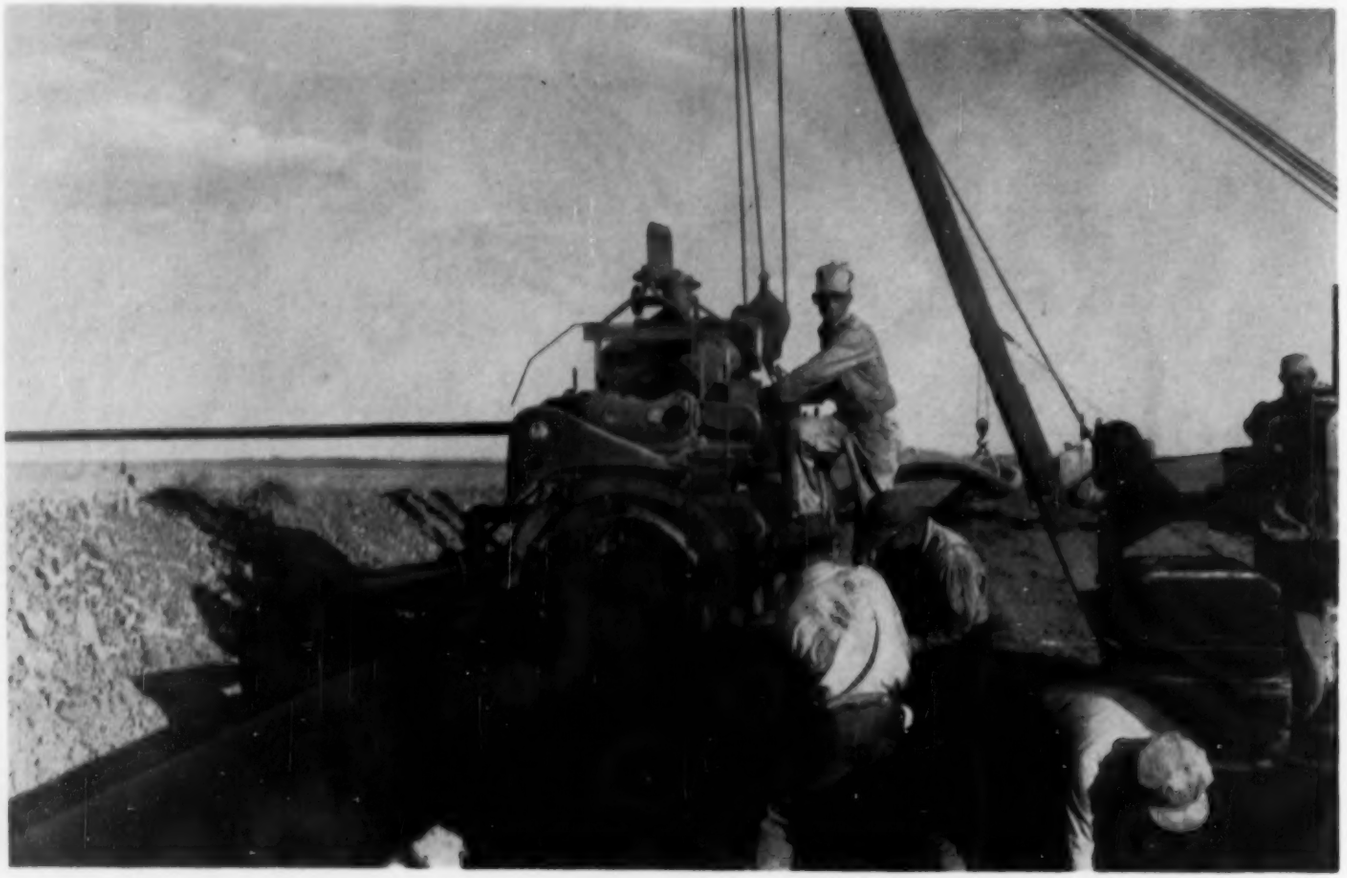
Structure contours on top of D sand. C.I.-250'.

pre Cambrian

PETROLEUM INFORMATION

Denver-Casper-Billings-Bismarck

Lithographed in U.S.A.



Gentle terrain and easy ditching through the Denver-Julesburg Basin helped surprisingly rapid completion of pipe lines to market. Coating and wrapping crew shown here is at work on Arapahoe Pipeline.

active in tne basin play, each of the affected cities had its own local crop of leasemen and new independent operators. This type of operator contributed considerably to the rapid movement of both leasing and exploration in the basin.

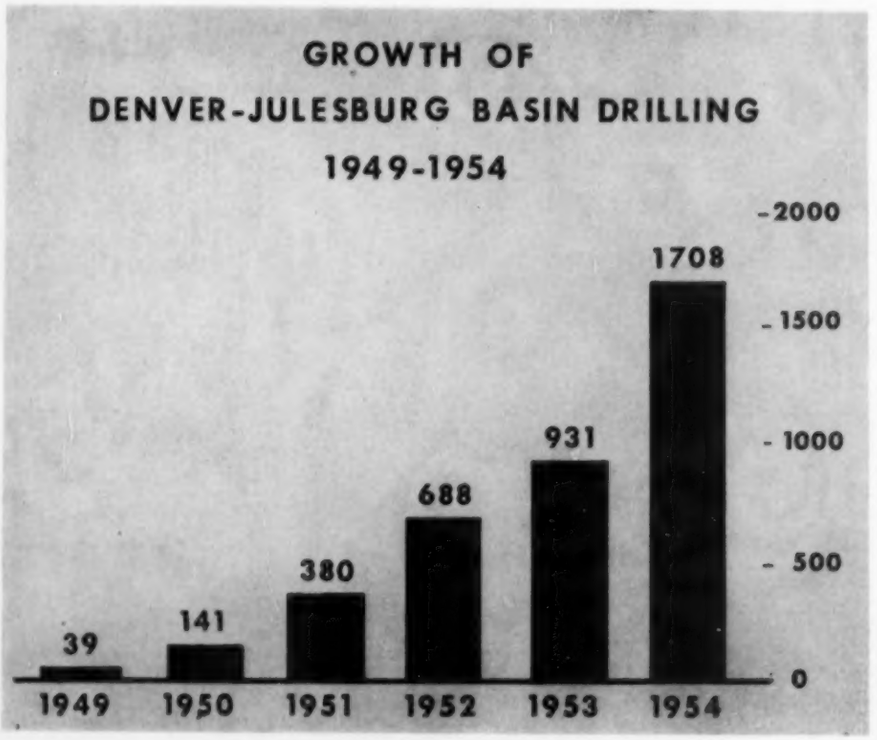
While the towns of the basin were developing as local centers of activity, Denver, as the only major city in the area, began to feel the influence of oil to a marked degree.

From the end of World War II it was apparent that the entire Rocky Mountain region was to enjoy accelerated activity. Need for expanding productive capacity as a defense measure indicated profitable possibilities of new activity throughout the region.

Previous concentration of production in Wyoming helped to place the early play there. Colorado's only major production was at Rangley field, with its development completed shortly after the end of the war.

Productive capacity necessary to the support of a major pipe line system for Rocky Mountain crude was the sorest need of the region when the postwar exploratory program began. Some of it was developed in Wyoming. Most of this early development and much of the older production was in the hands of the major operators.

Early development suffered for lack of



pipe line outlet and this situation was obvious by the time plans for the Platte pipe line were announced in early 1951. An injection station at Gurley provided for take from the Denver-Julesburg.

When this line was announced, a definite increase in activity through both Colorado and Nebraska was immediately apparent. In 1951 the basin had 380 completed wells by comparison with 141 in the previous year. By 1952 the annual total grew to 688 wells.

Under the impetus of this development in the basin, Denver began to assume importance as a central administrative point. Shell Oil, with much prior exploration, but no production, got its first oil in the Rocky Mountains in northeastern Colorado in 1950.

British-American Oil Producing, Ohio Oil, Continental Oil, Sinclair Oil & Gas were a few of the many established operators well-represented in early activity in the basin. Location of offices in Denver by these companies led to later location by a great number of independents who were interested in both individual and farmout activities.

By 1954 Shell had established a Rocky Mountain area office in Denver, several other major companies had Rocky Mountain headquarters there, and a continual influx of smaller operators to the city had been in progress for more than two years.

From 1952 to the present time, a period of major economic growth in the entire region, much definite field work also went on in the Denver-Julesburg basin. Underlying increased activity were two principal discoveries.

In 1952 oil was found in the Little Beaver-Badger Creek area of Adams and Washington Counties. A rapid development followed, as the area was attractive due to well-developed sand sections and good reservoir characteristics. Continental Oil, Lion Oil, Forest Oil, Sinclair Oil & Gas, and several local operators were active in this development. By the end of 1952 the field produced in excess of 10,000 barrels of oil per day, despite rather severe restrictions.

Little Beaver, when it became the second largest producing area in the state, underscored the importance of the basin. Previously, a field which developed to the point of producing 4,000 or more barrels of oil per day was large for the Denver-Julesburg. Few produced that much; many were one-well pools. But Little Beaver, with substantial reserves, changed the thinking on the potentialities of the basin. Major operators, who had previously been active mainly through farmout and support programs, turned to active campaigns in their own right.

Nevertheless, the next important discovery of substantial size was made by an independent. It was in Morgan County, in an area of practically no previous drilling, and became the Adena field, now producing more than 17,000 barrels per day.

DRILLING COSTS ON TYPICAL DENVER-JULESBURG BASIN WELL

Maps, Legal, Survey, Location Preparation	*$425.00*
Surface Pipe and delivery	*975.00*
Shoe and Cement	*419.00*
Coring (60 feet)	*780.00*
Tests (two)	*900.00*
Core Analysis	*200.00*
Log and Microlog	*1,000.00*
Geologist	*750.00*
Travel, telephone, auto, misc.	*500.00*
	$5,939.00
Contract footage (5,300 ft. @ $2.75 per ft.)	*14,575.00*
Five days rig work, cores, tests, etc.	*3,250.00*
Total to abandonment or to casing point	*$23,764.00*

Completion costs, including tank battery and treater on this well, if successfull, will be about $34,500.00. Subsequent completions will cost approximately $22,000.00 in the same field after total depth is reached.

During the early development of the basin, activity was so concentrated on Logan and Weld counties, that Morgan was left pretty much alone, although it lay directly in the path of the producing trend. Even when production jumped to the south in the Little Beaver-Badger Creek area, the intervening area in Morgan County was not drilled until the Little Beaver area was well developed.

Late in 1953, when the Adena discovery was made, the entire county had less than 100 completed wells. By the following April, so rapid was Adena's development that 129 wells had been drilled in the field area alone, with nearly all of them successful. This field amply illustrates the vagaries of the producing formations of the basin, with some wells producing as little as 100 barrels of oil per day on pump, and others nearby capable of an initial flow of more than 1,000 barrels per day.

In 1953 discovery of Lyons sand (Permian) production was made in the Keota field, Weld County. Although production here was small and soon went to water, additional deep exploration was spurred and the Black Hollow field to the west was discovered. The California Co. has developed this field which now has six wells producing from about 8,950 feet.

While the search for pre-Cretaceous production has not been particularly successful, the discovery of deeper production added a new dimension to the basin, and additional drilling to basement is still being conducted over much of its area.

With development of major producing fields such as Little Beaver-Badger Creek and Adena, and the rapid pace of general exploration which produced a number of other smaller, but good fields, pipe line outlet was soon at a premium. The Platte pipe line offered transportation to the Midwest, but feeder lines were necessary from the new fields.

The Toronto Pipeline Co. (British-American) completed a line from Merino through Sterling to Gurley in 1953. In the same year a line was completed from Little Beaver-Badger Creek to join Toronto at Merino.

With the development of Adena, Pure Oil, a substantial producer there, entered with Sinclair Oil & Gas into the construction of a line from Adena to Merino. Pure also built a feeder line from the Kimball area in Nebraska to the Gurley injection station on the Platte. This was feasible because of the great growth of production in Kimball County, now the most active Nebraska area.

In 1954 new production was found east of the old Harrisburg field in Banner County, Nebraska, with a considerable amount of development done there during the year and activity still heavy early in 1955. Of the new areas of production in Nebraska at the present time, the Harrisburg district is perhaps the most closely watched.

A major step forward for the basin came in the form of construction of two additional pipe lines to the Midwest in 1954. In late summer, Pure Oil and Sinclair Oil & Gas announced construction of an 80,000-barrel per day crude line to originate at Merino and cross Kansas to tie in with existing facilities in the eastern part of that state.

Within a few weeks, Service Pipeline Co. officials announced the formation of Western Pipeline Co. to construct a line from Fort Laramie in Wyoming southward across northeastern Colorado and into existing facilities in eastern Kansas. Eventual capacity of this line is 160,000 barrels per day. Injection in the Denver-Julesburg basin is at Sterling.

The new Western line connects with existing Service pipe line facilities in Wyoming and replaces a 60,000-barrel per day line across Nebraska, which was for many years the only major eastward outlet for Rocky Mountain oil.

With these two pipe lines built, capacity within the 195,000 barrel per day Platte system is freed for eventual use for oil from Wyoming as well as for further development in the northern portion of the Denver-Julesburg. Taken together, the new lines provided outlet equal to productive capacity at the time of their completion, a situation not previously enjoyed in modern times by the Rocky Mountain region.

More important, the two lines with major terminal facilities in the Denver-Julesburg pointed up the importance now attached to the reserves of the basin, and constitute an open invitation to further development.

The technical side of operations in the Denver-Julesburg is one of its attractive features. Production is found from 3,500 to 7,000 feet. A good average is in the vicinity of 5,000 feet. Lighter rigs, of the caliber of National 50s, are the rule. Such a rig will spend from seven to nine days making hole on a representative well. A good rule of thumb for the fast drilling of the basin is about a bit per day, making six to 10 bits the average for a completed well.

A dry hole will represent a total investment, in most areas of the basin, of less than $25,000, usually around $20,000. Completion of a producer will cost about twice that.

Drilling rigs in steady operation in the basin make more hole per rig in a given period than those in any other part of the Rockies. A good operator can tear down, move and be completing rigup on a new location in 24 hours. If the new location is within skidding distance, the rig can be moved off one location and spudded on another within 16 hours. With growing concentration of drilling in the basin, contract drilling is highly competitive, with the cost generally in the neighborhood of $3 per foot.

While dry holes are plentiful, the combination of now adequate market outlet, reasonable and efficient conservation measures and relatively cheap drilling makes further exploration of the basin certain. The fact that dry holes condemn only a very small surrounding area leaves plenty of room for further exporation even in the more active areas.

Each succeeding year, with its increased rate of drilling, has opened in the Denver-Julesburg new areas which immediately underwent intensive development. Last year additional discoveries were made in the more active, central producing area. Certain movements of new and successful exploration have particular significance for future work.

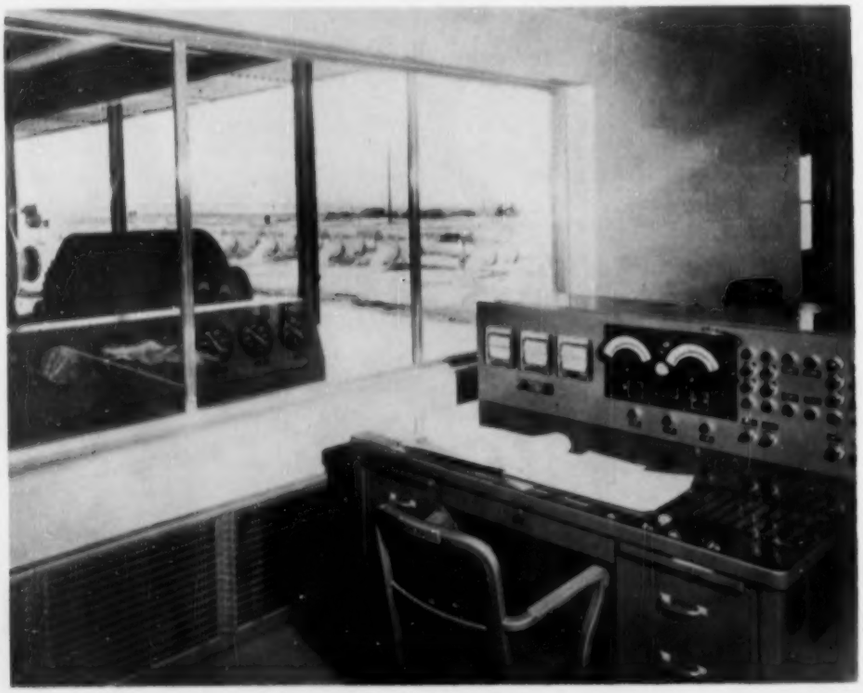
An important outgrowth of development of Adena was exploration to the east in Morgan County. This also spread to the south in Washington County. This expansion eastward was further advanced early this year with an apparent discovery almost on the Yuma-Washington County line. A large exploratory program through this part of the basin is a certainty for 1955.

There was also a definite movement of exploration to the west in Weld County. Farther north, in Nebraska, 1954 brought a steady northward expansion of producing areas in both Kimball and Cheyenne Counties.

Kimball County also had the most active year in its history for within-trend drilling. Movement of Nebraska exploration during 1955 is apparently to be in peripheral fashion around the Kimball-northern Cheyenne area of heavy exploration in 1954.

Late in 1954 several significant developments were reported away from the areas of greatest activity. Sinclair Oil & Gas began a sizeable exploratory program south of previous production in Elbert County and Arapahoe County. One small producer has already resulted.

Control panel at Merino station of the newly completed Arapahoe Pipeline built by Sinclair Oil & Gas and Pure Oil to tap Denver-Julesburg Basin reserves. Typical basin terrain is visible through station window.



In the meantime, leasing by a number of major operators as well as some independents spread south along the mountain front and east and south of the Las Animas Arch, the southern boundary of the basin. Additional Cretaceous exploration through the southern area of the basin is expected in 1955, with the possibility of deeper drilling in the more southerly area along the Las Animas Arch of definite interest.

Independent operators drilled a deep test in Jefferson County, southwest of Denver, in late 1954. This well, one of very few in the area, found oil in Codell, a new producing horizon for the basin. Additional tests are planned in this heavily-faulted area for early 1955, offering the possibility of important discoveries along the west flank of the basin. Production is at about 9,000 feet and drilling presents technical difficulties not found in the more regular basin areas of the east. Nevertheless, completion of the Jefferson County discovery will assure continued exploration.

The southeastern quadrant of Wyoming contains a substantial portion of the Denver-Julesburg Basin. With the exception of production at Horse Creek, on the west flank of the basin, and a few wildcat shows of noncommercial quality, the Wyoming portion of the basin has offered little encouragement. It has had relatively little exploration. Early this year a wildcat on the outskirts of Torrington, in Goshen County, more than 40 miles from nearest basin production, became an apparent success. Swab recovery of 115 barrels of oil per day from J sand was reported. This area has been active in recent leasing and a considerably expanded drilling program is expected in the Wyoming portion of the basin this year.

A quick summary of 1954 developments as already sketched would indicate that with the exception of the central area, the Denver-Julesburg has hardly been touched. A very large area remains to be tested by comparison with the area already in production.

There is little doubt that this basin will set the pace for Rocky Mountain exploration in 1955, perhaps for some time longer.

The experience of Forest Oil explains the attraction of the Denver-Julesburg. This operator came to the Rockies in 1952. The firm's first Rocky Mountain wildcat found a small pool in western Nebraska. The second was the Badger Creek discovery in Adams County, Colorado. The third was a discovery in the southern end of the Big Horn Basin in Wyoming.

Discovery in the Denver-Julesburg made this operator's Rocky Mountain operation a self-sufficient one. Last year, Forest had what is now believed to be the best discovery of the year in Wyoming. The firm now firmly entrenched, has a broad program for the region.

Prof. Filippo Pennavaria, chairman of the Press and Publicity Committee.

Dr. V. Cazzaniga, president of Esso Standard Italiana and chairman of the Hotel and Tourist Committee.

Ing. Mario Mortara, director of "Condor" and member of the General Organizing Committee.

Dr. G. E. Kovacs, general manager of "IROM" and chairman of the Committee on Finance.

World Congress completing plans for June

AS THE DATE for assembling of the Fourth World Petroleum Congress draws nearer, activities of the officials and organizations in charge are increased and a number of additional committees have been appointed by the organizing group to deal with specific matters that call for attention. One of these is the Editorial Committee for the Proceedings under the chairmanship of Ing. Mario Mortara. Dott. Vincenzo Cazzaniga is chairman of a committee to deal with hotel accommodation, reception and tourist arrangements. A Press and Publicity Committee is under the chairmanship of Prof. Filippo Pennavaria. Dr. Giorgio Erberto Kovacs heads the important committee on Finance.

A special committee is to be formed to welcome the ladies attending the Congress and to arrange for their entertainment. Various social events and tours of special interest to women visitors and others are being added. An operatic performance of *La Traviata* will be presented at the Opera House on the evening of June 10.

An important event during the last week of January was the presentation and review of the papers collected for delivery at the technical sessions of the Congress. Upward of 230 papers, all of which (except a very small number) already have been delivered to the Technical Committee, of which Prof. C. Padovani is chairman, and have been read, edited and prepared for printing. The list of titles and authors made public at the time of the meeting shows that the largest number of papers have been supplied by the United States, Great Britain, France, Italy, The Netherlands and Germany in the order named.

The most numerous papers are those to be presented in the sections dealing with geology and geophysics, oil processing and the utilization of petroleum products, but very full programs are also prepared for presentations in the sections dealing with drilling and with the production of chemicals from petroleum.

Due to the care with which the subjects and authors have been selected—in many cases through national committees of leading technologists in various countries — the range of topics covered in the technical sessions will be much broader than has been the case at preceding Congresses.

Extension of interest in the Congress and the development of improved techniques toward which its meetings and discussions contribute is indicated by the fact that 33 countries are now members, maintaining national committees or acting through affiliation with other national groups.

Consideration of the program of tours contemplated in connection with the Congress has led to the selection of six routes, all of which combine the opportunity to see some of the most modern of Italy's petroleum plants along with the scenic and historic attractions which compel the attention of all visitors to Italy. Of these travel tours, one leads from Rome to Florence and permits visits to the AGIP refinery at Cortemaggiore, the Condor at Rho and Sarpom at Trecate. A tour to the south will provide an opportunity to visit the refinery of Socony-Vacuum Italiana at Naples and for those who can add another two days to the trip, a stop at the Rasiom plant in Augusta, Sicily. Those who select this tour will have the opportunity of visiting Capri, Sorrento and other famed beauty spots along the southern coast.

Tour No. 3 will proceed northward from Rome to Genoa and Turin with visits to the Inpet refinery of Shell at La Spezia, that of Purfina at Genoa and the Fiat automobile plant at Miraflori. Travelers by this route will have the opportunity of extending their trip to Mount Blanc and the Italian Alps.

Other excursions to the north and eastward will conduct visitors to Florence, Pisa and Leghorn, seat of the Stanic refinery, by one route, or to Venice, Trieste and the scenic attractions of the Dolomites on the other. Visitors following these routes will have the opportunity to visit the Irom refinery at Venice and Aquila at Trieste. Another itinerary will cover this same general area, but with visits to Ancona, Rimini, Bologna and the Montecatini plants at Ferrara, the largest chemical works in Italy.

These tours have been planned with care to permit visitors to the Congress a wide latitude in the choice of areas to be visited and allowing them to combine views of the country's most celebrated historic and scenic attractions with visits to industrial districts and plants that may be of particular interest.

Seismic recording boat and shooting boat keep moving while charge goes off and recording is made. Calm weather speeds operations. Photo courtesy Vector Manufacturing Co.

New instruments

By Robert M. Stonedale

EFFECTIVENESS of geophysical prospecting is expected to benefit during 1955 from several recent instrumentation advances as well as some changes in operational techniques necessitated by the shift to more difficult exploration areas, offshore and on land. Geophysical activity during the past year has been at one of the highest levels on record, excluding 1951-52, when the United States tax structure provided an especially sharp spur to petroleum exploration in general. Expenditures for geophysics are expected to increase in 1955 due in part to increased offshore activity.

As the search for oil moves into more difficult prospecting areas, the problem of procuring accurate subsurface information becomes more complex. "Coarse" reconnaissance information has become less and less valuable since many of these areas have been investigated previously and present-day efforts are directed towards pin-pointing smaller structures. This trend has demanded instrumentation improvements which permit detailed analysis of sub-surface information.

The two most active operations in geophysics today, as has been the case for several years past, are seismic prospecting and gravity meter surveying. Gravity meters have become smaller, lighter and more accurate during the past few years and today many virgin areas are first covered by gravity meter surveys. Continued development of the meter's elastic systems has made them more resistant to shock damage while preserving sensitivity.

Excellent results with gravity meters have been achieved in marine exploration. In these operations a gravity meter must be positioned on the ocean floor and read in that location. Special equipment has been designed for that purpose, most of the installations being of the "diving-bell" type where the meter is lowered to the ocean floor in a watertight housing. The meter is leveled and observations are made by remote control from the deck of the surveying vessel. Much accurate prospecting has been done by this method

aid geophysics in critical-area prospecting

and, economically speaking, the gravity technique has resulted in the saving of many crew months of seismic operation in preliminary investigation of offshore prospects.

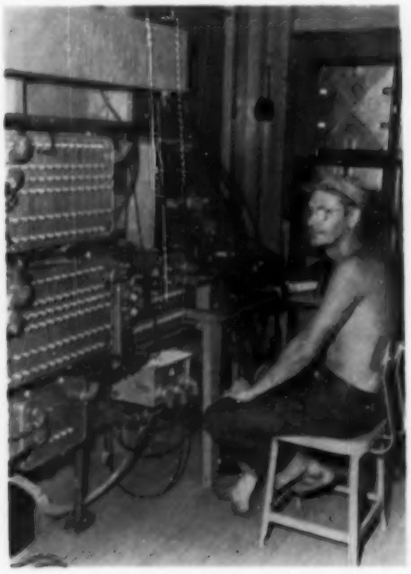
It is in seismic instrumentation and operation that the most notable changes are in prospect. As seismic activity has been concentrated in more difficult recording areas and finely detailed analysis of previously shot prospects has been under way, the seismic industry has had to face an increasing problem of high noise-level interference.

Generally speaking, the usefulness of seismic records is a function of the ratio between the signals reflected from subsurface strata and the "background" noise. Noise may be defined in general terms as any information appearing on the seismic record which is not caused by a signal reflected by the strata under investigation. In areas regarded as "critical" the ratio between the noise and signal is low, either as a result of weak reflected signals or because of large amounts of random noise arising from the shot. The lower the ratio of the reflected signal to the recorded noise the more difficult the interpreting task, due to the difficulty in identifying reflections and segregating them from random noise. This is an especially severe problem where several strata are being carried on the cross sections and some of the reflections are weak.

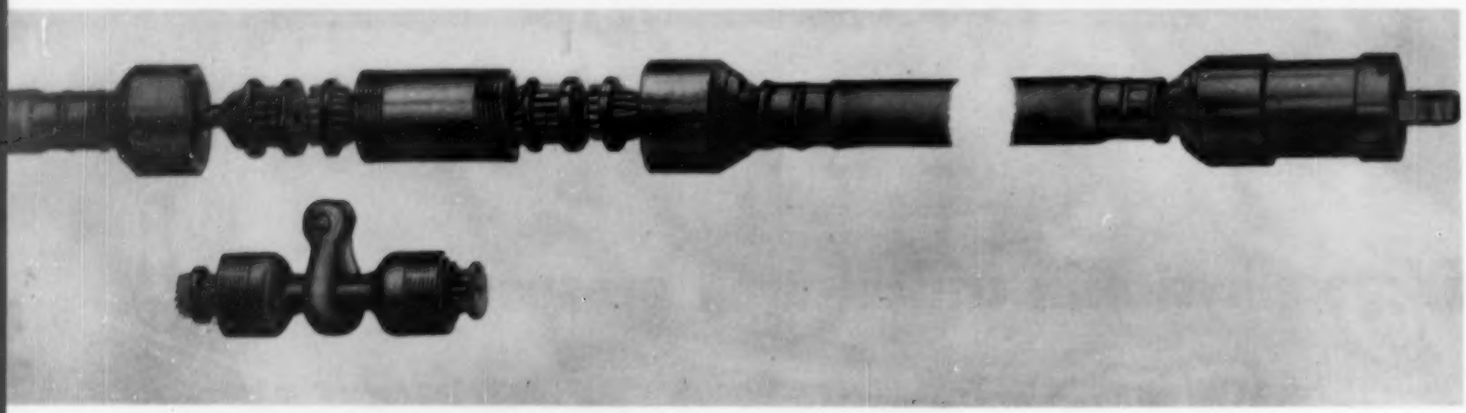
Several methods have been developed for improving the ratio of the signal-level to the noise-level. Among these are the use of multiple geophones, where as many as 48 geophones may supply each recording channel. The phones at each station are connected to one amplifier channel in the seismograph system and are so spaced as to react almost simultaneously to a reflected signal while generating out of phase signals in response to random noise. This method has proved of value in many areas, but has limitations. Considerable time is required to handle and connect the large number of geophones.

Another problem in some of the critical areas is the difficulty of generating a sufficient signal from the dynamite charges to give rise to reflections without also generating too much noise. This is especially true in some areas of West Texas where unconsolidated surface deposits "break-up" the wave front from the dynamite explosion before it penetrates deeply. One of the methods applied to this condition has been the use of multiple shot-holes. Twelve, 24, 36 or more shot-holes are drilled at intervals in a geometric pattern and the charges in each hole exploded simultaneously. As much as 1,500 pounds of dynamite may be exploded at once with this method. The pulses from the shot-holes reinforce each other and give rise to one large pulse which often generates suffi-

Complete 24-channel seismograph installation in instrument room of offshore recording vessel. Photo courtesy Southwestern Industrial Electronics Co.



Light weight instruments in converted pick-up truck allow fast travel in favorable terrain. Photo courtesy SWI.



Marine cable assembly showing geophone cases of naval bronze and heavy-duty construction to withstand towing strain. Cable is protected by heavy, water-tight rubber boots and hose. Photo courtesy Vector Manufacturing Co.

cient energy to give rise to a suitable signal. The holes are so arranged that random energy from each shot-point tends to cancel out.

This method also has its limitations due largely to drilling expense. Eight or more drills may be required to drill the number of shot-holes required for one recording crew.

It is in instrument design that the most progress has been made in critical area recording. Burton McCollum, well-known geophysicist of Houston, Texas has developed a "signal integrating" method with special equipment to reduce the noise problem and to eliminate the need for shot-hole drilling.

In the McCollum "Geograph" system, pulses are generated by dropping a three ton weight suspended from a crane on a truck. While each pulse thus generated is relatively weak, it also generates much less random noise than a dynamite explosion. A magnetic recording disc is used and as the weight is dropped at various points along a line, a new recording is made. The recordings are composited and the out-of-phase random noise components tend to cancel each other. Tests conducted by the McCollum organization and the geophysical departments of several major oil companies show the weight dropping method generates as much useful energy as 2½ to 50 pounds of dynamite in many areas.

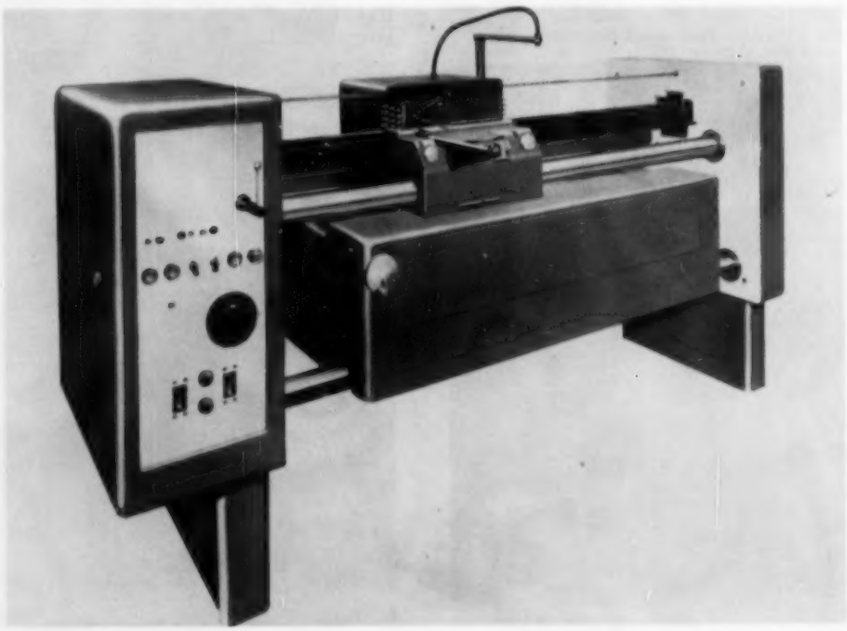
This brings us to a discussion of the magnetic recording technique which has been the major advance in instrumentation during the past year and which promises to have a profound effect on seismic activity in the near future.

Conventional photographic seismic records portray the information from the geophones as changes in the attitude of photographic traces on sensitized paper. If all the information arriving at the surface were recorded on the paper, the resulting confusion of traces would make it impossible for the geophysicist to identify the reflections. For this reason, the dynamic range of the recorded signals is reduced to a value suitable for optical presentation. Conventional seismic instruments are also equipped with selective filters which are adjusted by the operator to remove much unwanted information, especially that arising from random noise. In the critical areas, however, this method also removes some information which may be of aid in identifying reflections.

In magnetic recording a very wide-band amplifier is used and all of the information arriving at the surface is recorded on the magnetic tapes without subjecting it to filtering, mixing or other applied effects. The extremely wide dynamic range of the tapes allows virtually "pure" recording of the geophone signals. The magnetic tapes are taken to the interpreting laboratory where they are played back by transcribing equipment. This method literally brings the shot into the laboratory for analysis.

Various degrees of filtering and mixing can then be applied to achieve optimum optical presentation. In addition, records taken at different shot depths or locations can be integrated to reduce the noise-level and the resolved information can be presented on one record.

Reynolds cross-section plotter. This revolutionary automatic computing device scans seismic records, identifies reflections and corrects "raw" times. Photo courtesy SWI.



This technique has been under experimentation by major petroleum companies for some time and has finally passed the laboratory stage. One of the major seismic instrument manufacturers and several newer organizations are now producing magnetic recording equipment for the seismic industry.

In producing this equipment several problems had to be overcome. The strength and durability requirements for field operation in trucks required special designs capable of withstanding severe shock and vibration. Also, considerable attention had to be paid to reducing the inherent noise-level of the equipment. Finally, very accurate control of record timing had to be achieved since any timing inaccuracies in the machine would be multiplied each time a record was transcribed and could result in large errors in final interpretation.

These problems were successfully solved in at least one of the equipments now being offered commercially and this instrument is now in use in several difficult recording areas.

In addition to the magnetic tape method, improved results have been achieved in the critical areas with complex versions of conventional seismic systems. One of these now in use in West Texas was custom-designed and manufactured by a seismic instrument manufacturer at considerable cost exclusively for difficult area operations. This instrument embodies extremely wide dynamic range, special automatic gain control characteristics, numerous filter combinations and probably more mixing and recording options than any other seismograph system in current use.

Complex "critical area" seismograph systems are now being offered by several manufacturers and these are distinguished by the wide number of filter combinations offered, unique AGC circuits featuring very wide dynamic range and easily-chosen recording options for various types of record presentation valuable to the geophysicist in difficult area interpretation.

It is in the field of offshore marine seismic prospecting that the best operating efficiency has been achieved. These offshore crews move at a tremendous rate, shooting records as often as once each minute. In the preferred method of operation, the recording boat towing the special marine geophone cable does not stop when it passes a pre-surveyed shot location; the charge is fired and the record is made with the boat in motion.

Conventional instruments are often used in these operations, but special geophone cables capable of withstanding the towing strain and moisture problems encountered in marine operation are necessary. The cables are complex devices with geophones mounted in special cases which are integral with the cable sections. Special devices are used to tow the cables and a wide range of accessories such as marker buoys, transferring plugs and others are used. The detectors are often gimble mounted in their cases to keep them properly oriented to the ocean floor during shooting. The special cable and accessory equipment is essential to high speed offshore operations. The manufacturer of the special cables maintains an engineering division which concentrates on marine cable design exclusively. Cables which can be used in weather formerly considered too rough for operation are now available as a result of the design program.

One of the major problems in offshore work is the time required to compute reflection times on the large number of records shot daily, converting the times to equivalent depths and preparing cross sections. The number of computers required for two or three water crews, and in fact the personnel in general required, is sufficient in both numbers and cost to operate five times the number of land crews. Thus, while the total numbers of seismic crews active in 1954 was slightly less than previous record highs, the total expenditure was as high or higher than ever before.

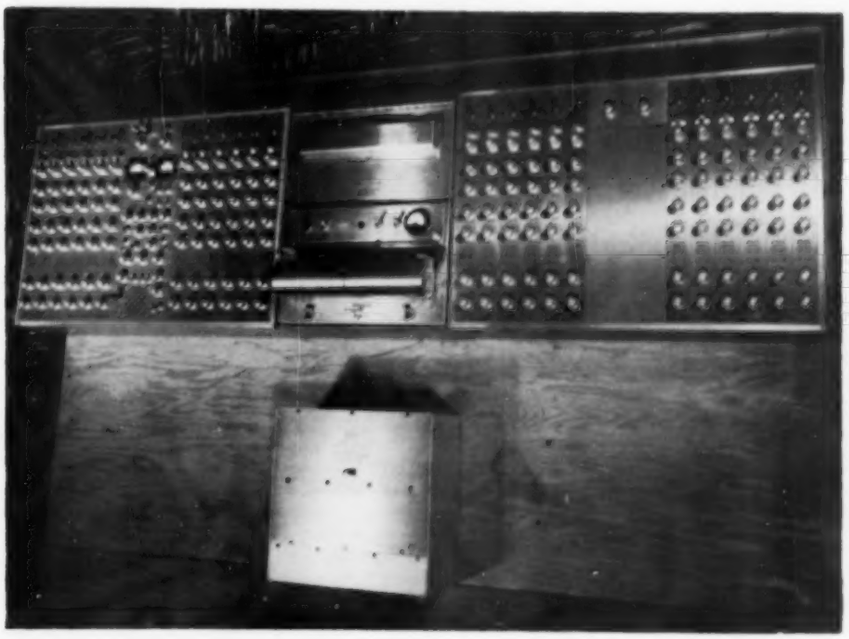
Magnetic recording also has been adapted to marine operations with considerable success. In many areas, however, signal strength is not a problem and the more complex technique is not required.

An innovation holding forth much hope for increased efficiency in offshore operations is a revolutionary automatic computing device developed by V. T. Reynolds, Houston geophysicist. This device, known as the Reynolds Plotter, automatically scans special photographic records, notes the in-phase information appearing on the various traces on the record and produces a photographic record in which the tedious and time-consuming part of the computing operation has been completed automatically. In effect, the Reynolds Plotter produces a cross section of the reflections at several shot points, eliminating difficult reflection identification and time conversion operations and hand plotting of the events on cross-section paper. One of these devices is now in use by an offshore seismic contractor and reportedly is achieving considerable success in reducing error and in saving computing time.

A more complex and versatile version of this equipment is now being produced by the Southwestern Industrial Electronics Co. and it is expected that the new instrument and other data-reduction equipment will find wide application during the coming year.

Thus it appears that 1955 will be a notable year in both critical-area and offshore seismic surveying. New advances in instrumentation such as magnetic recording and more versatile seismic instruments will improve the recorded signal-to-noise ratio, thus facilitating event identification and improving quality of results. New automatic data reduction and interpreting equipment promises to reduce interpreting costs and improve accuracy while assaying information which would occupy the services of hundreds of computers and mathematicians.

Newly-designed "critical area" seismograph system features numerous filtering and recording options. Complexity of instrument reflects problems encountered in present-day difficult-area prospecting. Photo courtesy SWI.



PROGRESS

A Schlumberger service truck used in electrical logging.
Photo courtesy Schlumberger Well Surveying Corp.

in well-logging techniques

By Lester C. Uren*

ONE OF THE most important developments of the past four decades in the art of drilling oil and gas wells has been the remarkable progress made in well-logging techniques. Many millions of dollars have been spent in research and field equipment. Thousands of technologists have been employed. As a result, a variety of different logging methods has been developed and great service organizations have been established to apply them in all of the active oil-producing centers. Former primitive logging practices have been displaced by scientific methods that accurately indicate the lithologic character of formations penetrated by a well and their fluid content.

When one considers the difficulties presented in appraising conditions in a well, but a few inches in diameter at depths of many hundreds or several thousands of feet below the surface, where every operation must be conducted by remote control, it is not surprising that early operators made slow progress in devising means for identifying the formations through which they drilled and often entertained inaccurate concepts of the subsurface conditions with which they had to deal. The logs of wells drilled during the first 40 or 50 years of the American oil industry are little more than skeleton records, with only sketchy and often inaccurate descriptions of the formations penetrated.

The cable drillers of the Appalachian region were able to identify broadly the various types of formation samples brought to the surface by the bailer or as bit samples. Shale, sandstone, limestone and other common rock types can be distinguished one from another without any particular training or knowledge of mineralogy or lithology. The color of the sample and, in the granular rocks, the size and shape of the grains, afforded an additional basis for classification. It became the custom for the driller to note and record these observations as the wells were drilled, indicating the depth to top and bottom of each recognizable stratum. Thus, the "driller's log" became an essential by-product of every drilling operation and the industry developed more or less common forms for recording and graphically displaying the information that they afforded. It was convenient to combine other essential records with the stratigraphic report, particularly the casing record; fluids encountered in different strata, such as oil, gas or water; critical dates; initial rates of production of oil and gas and other items such as the names of drillers. Eventually the recorded log of the well became a detailed history of every phase of the drilling operation and of all observations made during the course of drilling and completion of the well.

When rotary drilling started, about the beginning of the present century, new problems were presented in assembling dependable drillers' logs. Drill cuttings were brought to the surface by the circulating fluid in finely divided form, so contaminated with clay that it was often difficult to recognize the character of the formation in which the drill was operating and changes in lithology in thin-bedded strata were not apparent. Because of the pressure imposed by the circulating fluid, it was difficult to identify the nature of the fluids in different formations penetrated. Early rotary drillers sometimes drilled through oil sands capable of commercial production without recognizing them.

Mechanical coring: Because of these difficulties and uncertainties, the rotary driller soon began to seek more dependable means of identifying formations penetrated than mere sight-inspection of drill cuttings. Means of taking formation samples in the form of cylindrical cores cut from the rock exposed in the bottom of the well with special "core barrels" were developed. The first tools of this type were primitive and often produced samples damaged by excessive overheating, compaction and contamination by drilling fluids, and in which only a small percentage of the interval cored was recovered. But with the development of the double-tube core barrel and improved types of cutter heads, and with greater skill on the part of the driller in operating the equipment, it became possible to secure core samples that were fairly representative of the rock strata as they existed in the bottom of the well with a high percentage recovery of the interval cored. Such cores afford dependable samples for lithological identification of the material, but because of contamination with drilling fluid and bit pressure employed in cutting, most cores do not provide a dependable quantitative indication of the fluids present in the pore spaces of the sample. Nevertheless, properly cut cores afford dependable qualitative information concerning the nature of the contained fluids.

In passing, mention should be made of

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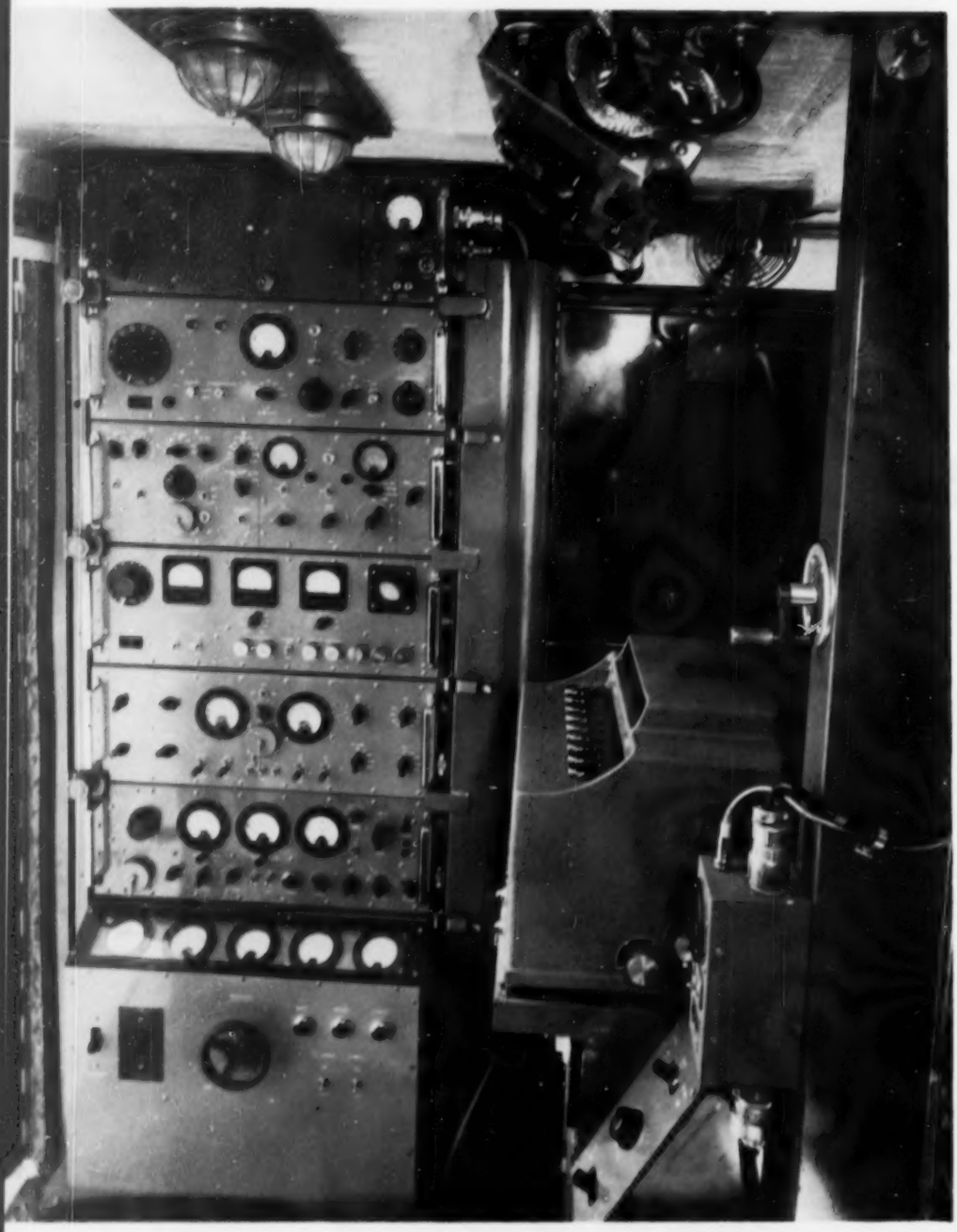


Instrumentation plays an important role in electrical logging. Shown here is an interior view of components in a Schlumberger service truck. Photo courtesy Schlumberger Well Surveying Corp.

the utility of the diamond drill as a coring device. The drill was developed prior to 1900 to provide continuous cores of all formations penetrated and has been widely employed in sampling operations in coal and metalliferous deposits. Because of the relatively small size of the hole drilled and depth limitations, it has not been so generally used in the petroleum industry. Since about 1925 it has been successfully employed in coring operations incidental to secondary recovery operations in many oil fields, and during very recent years, diamond-set cutter heads have been used on conventional rotary core barrels.

Thoroughly satisfactory core barrels designed for use in rotary drilling were available and had been extensively employed prior to 1920. The early coring tools were well suited to use in soft and moderately hard formations, but it was not until somewhat later, when cutting elements patterned after the cone and roller rock bits were employed, that rotary core barrels of universal application were devised.

Conventional rotary core barrels are designed to be operated in place of the usual drilling bit, on the lower end of the drill column. Their use requires a "round trip" with the drill column to lower the tool to bottom and bring it back to the surface with the core. This involves substantial loss of rig time, labor and power and makes coring by this means expensive. Considerable economy is realized by use of the more recently developed wire-line coring tools, designed to be lowered through the drill column on a light wire cable into cutting position in a specially designed drilling bit, and retrieving the core and core-cutting elements by the same means without removing the drill column from the well. Though the cores obtained by this means are somewhat smaller than those produced with conventional core barrels, they are large enough to provide thoroughly dependable formation samples.

Until about 1930 the only coring devices available were designed for bottom-hole use, but at times it is necessary to take samples from the wall of a well after it has been drilled deeper than the formations from which samples are desired. For this purpose, a variety of side-wall sampling devices have been developed, some operated by mechanical or hydraulic means to punch out a core from the wall of the well and one patterned after the gun perforator and designed to drive a retrievable coring tool into the wall of the well with the aid of a high explosive.

Core barrels for use with cable tools have been developed but, because of the impact action of the cable tools, have never achieved quite the dependability and utility of the rotary core barrels. The cores taken with cable tools are usually broken into thin disks, but in hard formations a fairly satisfactory percentage recovery is obtained.

Formation samples of the kind described in the foregoing paragraphs are given preliminary inspection on the derrick floor as they are removed from the coring tool. One skilled in this work, usually a geologist or petroleum engineer, is able to classify the lithologic types presented, record the thickness of individual strata, determine the nature of the fluids present, and may even observe and measure the dip of the strata. If the well has been surveyed, it is possible to orient the core by various means and actually to compute the direction and amount of dip of the strata. All of this is important information that should be incorporated in the log of the well.

Additional information that is often important, particularly in reservoir strata,

may be obtained by careful sampling of the core at the well and sending representative samples to a laboratory for determination of porosity, permeability and fluid content. A paleontologist may also give the samples microscopic inspection to determine the character of microfossils that are often present. This is helpful in correlating formations and in age classification. Studies of the mineral content of core samples may also assist in stratigraphic correlations. By 1935 most of the larger oil companies were following core inspection routines of the kind here suggested and it is now common to find the results of core studies included in the official logs of wells. In the drilling of exploratory wells and critical wells where a special effort is made to assemble all available information, large sums may be spent in mechanical coring and in technologic studies of the cores taken in the routine of drilling. Oil companies often employ technologists especially skilled in core inspection and interpretation; men who devote their entire time to this work of assembling detailed log data.

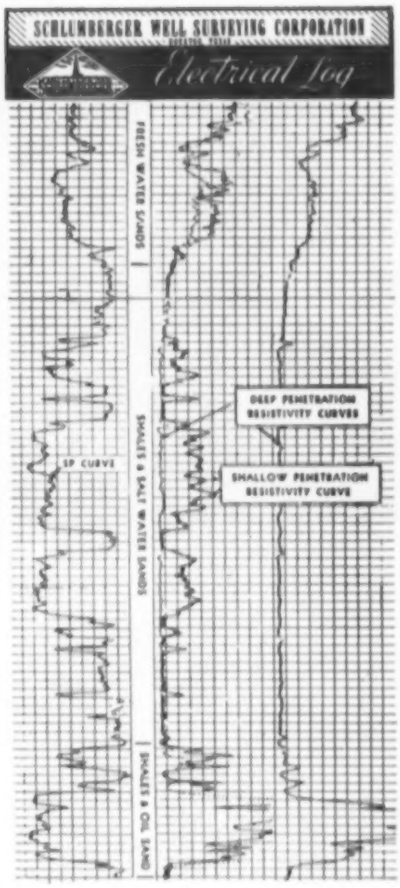
Development of coring tools and techniques of formation sample inspection have made notable contributions to the development of the modern well log, but it has become apparent that core data can scarcely be depended upon to provide a complete record of the formations penetrated in drilling a well. The cost of mechanical coring becomes prohibitive when it is applied to great thicknesses of formation and the operator usually must be content with occasional cores taken at critical intervals where the information thus obtained will be particularly helpful.

Electrical logging: The apparent limitations of mechanical sampling techniques have led technologists to study other possible methods of obtaining subsurface information from the bore of a well and in 1932 a radically new system was introduced that was destined to revolutionize the industry's logging practices. This was electrical logging, considered by some to be the most important single contribution to the science of oil-field development of the present century. The electrical system of logging was an outgrowth of research on the electrical method of geophysical exploration, by Conrad and Marcel Schlumberger, French geophysicists. In 1941 they jointly received the Anthony F. Lucas Gold Medal Award by the American Institute of Mining and Metallurgical Engineers "for distinguished achievement in improving the technique and practice of producing petroleum." In commercializing their discoveries they formed the Schlumberger Well Surveying Corp. which, over the years, has built a world-wide service organization and has maintained its leadership in this ever-expanding field though other service organizations now share this business. So important has the art of electrical logging become that a large percentage of all of the wells currently drilled in the United States are electrically logged.

Many patents covering various phases of this art have been granted and the methods and equipment employed by the different service organizations differ somewhat in detail, but the ultimate objective is always to measure and record two electrical parameters that are characteristic of the formations penetrated as a well. These are the resistivity of the strata and the so-called "self-potential." Both are automatically recorded on a depth scale in the form of "curves" or profiles on a strip chart covering the stratigraphic interval traversed by the logging instrument in the well. The logging instrument is lowered and raised through the well on the end of a multiconductor insulated cable which transmits an electric current from a surface source and releases it through an electrode so that it passes through the well fluid and into the formation surrounding the instrument in the well. Other electrodes measure the resistivity of the formation and, with the aid of electronic and photographic devices, the variations in electrical responses transmitted through the supporting cable are automatically recorded in surface equipment. Two (sometimes more) resistivity measurements and the self-potential measurement are recorded simultaneously. Spacing and arrangement of the electrodes of the logging instrument control the depth of penetration of the current. One shallow-penetration resistivity curve measures the resistivity of strata immediately about the wall of the well; the other, a deep-penetration curve, indicates resistivity of the strata a greater distance from the wall of the well where the result is less influenced by conditions within the well. These electrical parameters develop a kind of pattern that is characteristic of the formations logged and affords a basis for predicting their lithologic character and fluid content. Prominent points on these profiles are recognized as "electrical markers" that are helpful in correlation of strata from well to well throughout the field.

Here is a unique system of logging that provides an entirely different basis for characterizing the formations penetrated by a well than the record provided by the driller's log and by the results of formation sampling and testing. One skilled in the interpretation of such records is able to estimate the kind of rock in each stratum logged, its porosity and permeability, and whether it contains oil, gas or water. The transition from one stratum to another is often clearly defined so that it is possible to determine accurately the depth to top and bottom of each oil and gas producing zone and each water-producing interval.

Many complex factors control the



Portion of a typical electric log. (Courtesy Schlumberger).

magnitude of the electrical parameters recorded on the electrical log. At first it was thought that they could offer only qualitative information, for many disturbing and apparently inexplicable variations in the recorded data were noted. But gradually, after years of painstaking research, methods have been devised for measuring and correcting for the various factors involved, so that it is now possible to give truly quantitative interpretation to the recorded data.

Better understanding of the factors involved in electrical logging has disclosed that the arrangement and spacing of electrodes in the logging instrument must be varied to accord with conditions presented and with the objectives sought. Limestone formations and highly saline well fluids present special problems. For detailed records in thin-bedded deposits, resistivity is preferably measured by the "microlog" instrument, with closely-spaced electrodes maintained in actual contact with the wall of the well. A variation of this is called the "microlateralog" in which a focused beam of current penetrates a narrow segment of the formation

(Continued on page 96)

The turbine drilling system

By George G. Rosu

CONSCIOUSNESS of some of the shortcomings of the rotary drilling system resulted, as early as 1923, in the formulation of the principle of the turbodrill by M. A. Kapelyushnikov, a Russian engineer who later became an associate member of the Soviet Academy of Sciences. He called his invention the "motorbur" (mototrepan). A year later, he was successful in constructing the first experimental apparatus which he renamed "turbobur" (turbotrepan).

The first model went through a series of transformations before it could be successfully used in the field, the span between the invention and its industrial use being about 20 years. Even today the turbodrill is being constantly changed and improved in order to fit practical requirements.

The novelty of the turbodrill system consists in the fact that the driving force has been moved from the surface to the bottom of the hole. The power is not supplied by the engines at the top of the well, but by a hydraulic turbine mounted on the lower end of the drill string just above the bit. The hydraulic power is generated by the circulating drilling fluid which penetrates through the turbine and sets it in motion. The drill pipe is no longer rotated for power purposes, as in rotary drilling. Its main role is to hold the turbotrepan, to equilibrate the torsional moment caused by the reaction of the turbine and, particularly, to conduct the drilling fluid to the turbine. The rotation of the bit and the downward pressure on it is powered by the turbine itself, which descends in the hole together with the bit. These two pieces are the only actuated parts of the drilling equipment.

The mechanical principle of the turbo drill is the same as that of a simple hydraulic turbine in which the waterfall passes through the stator's channel. The drilling fluid is given a rotational, clockwise deflection in the stator's vanes and then, under a certain angle and speed, is directed upon the rotor's vanes which are thus set in motion.

The hydraulic motor fulfills the reverse function of a pump. The drilling fluid is discharged into the well through holes in the bit, where it washes up and lifts the drilling cuttings in the same way as in rotary drilling. The main power source in turbine drilling is the pump. For this reason, the pumps are more powerful than in rotary drilling and the surface equipment is designed for high hydraulic efficiency.

Although in turbine drilling the drill pipe column does not rotate with the drilling bit, it would be erroneous to assume that the system dispenses altogether with the swivel and the rotary table. With the exception of the pumps, however, surface equipment is much lighter than that used in rotary drilling because the mechanical effort it is called upon to perform is also lighter. The rotary table is used, in the main, for auxiliary work, but practice has proved that, in certain formations, the drill pipe must none the less be rotated at a slow rate in order to avoid pipe sticking.

The advantages of turbodrilling stem from the fact that only the bit is actually involved in the rotating effort. Its obvious benefits are:

A) Reduced depreciation of the drill pipe and diminished accident frequency. With the power motor at the bottom of the hole, the drill string is relieved of the supplementary torque required to cancel the tangential effort against the walls of the well, as well as the centrifugal forces that cause the twisting-off of the drill pipe. The lessened torque on the drill pipe reduces the causes of failures, particularly of the costliest types of accidents —breakages and twist-offs.

B) Elimination of most of whipping and rotation stresses reduces the external wear on the drill pipe and tool joints. Thinner pipes can thus be used, resulting in substantial savings.

C) The hole is straighter because the drill pipe string is seldom and then only intermittently rotated, and because of the absence of whipping and planetary motion of the bit. This simplifies the casing and cementing operations.

D) The more uniform application of weight on the bit in turbine drilling produces a higher penetration rate. This rate does not depend on—and hence does not diminish with—the deepening of the hole, as in rotary drilling: the rotation speed of the bit is not lessened by the resistance caused by friction.

E) In turbine drilling less weight is required on the bit. The power applied on the bit is kept almost constant as the hole is deepened. Inasmuch as the bit is subjected to less shock and wear, its life is comparatively longer.

F) Finally, the comparatively inactive surface equipment—which is seldom rotated—reduces accident hazards and the absence of the characteristic noise at the top of the hole diminishes the fatigue of the workers.

Dr. Rosu is known to our readers through his previous contributions to WORLD PETROLEUM *on fuel problems in the Soviet orbit. In this article, the author presents the salient facts on the application of turbine drilling in the Soviet orbit. Although the principle of this drilling method was formulated 32 years ago, literature on the subject is scanty. This is believed to be the first effort in Western literature to discuss this subject from all its angles. The author gathered the documentary material from Soviet and satellite sources available in this country and in Western Europe over a long period of time. His impression after going through piles of this material is that Soviet technicians are still today in the dark about many questions concerning turbine drilling. Among the obstacles the author encountered in appraising the sources of information were the lack of operating results and the difficulty in checking and eliminating contradictory statements and unwarranted eulogies from real facts. EDITOR.*

and its application in the U.S.S.R.

• The first "turboburs" constructed by Kapelyushnikov in 1924 were one-stage apparatuses of 6- to 8-inch diameter. Their structure was simple: a reaction turbine and a speed-reduction mechanism with a bevel gear of the Barett type.

The trepan was screwed on at the reduction gear axle. The whole apparatus was mounted at the lower end of the drill pipe through which the mud stream was circulated. But, although the principle of the turbodrill was theoretically accurate and looked perfect on the blueprints, its performance was far from satisfactory.

All models built during the next ten years were one-stage turbines which developed a power of 4 to 6 hp at a motor speed of 1,600 to 1,800 rpm. When they were tested in the field, the power put out proved to be far from sufficient to drive the drilling bit, and the useful life of the apparatus much too short to serve as the heart of a new drilling method. The latter shortcoming was caused by the great circulation speed of the drilling fluid which, in addition, had too high a sand content. The sand quickly ruined the turbine's elements, and caused a rapid wearing of the reduction gear.

The problem to be solved, therefore, was to increase the turbine's power while maintaining the volume of the mud stream at a constant level. The Russian technicians tried to raise the stream speed—up to between 8,000 to 12,000 feet per minute—and to replace the reaction turbine with action turbines, but did not succeed in lengthening the life of the turbodrill.

All contrivances built during this decade had the same congenital defects: they were small-size tools with a short useful life, and capable of drilling only at shallow depths. These are unavoidable deficiencies of all one-stage pressure hydraulic turbines. During this early, experimental period, the turbine drilling method was too costly and, consequently, unable to compete with the performances and economic results of the rotary drilling system.

In 1932, a suggestion was submitted to alter the basic principle: that is, to construct turbodrills not with single, but with multi-stage turbines. This type of turbine is capable of developing considerable power at a reduced drilling fluid circulation speed.

In 1934, the turbodrill collective of the Ordzhonikidze Trust in the Caucasus, led by P. P. Shumilov and with the assistance of Staneyev, began constructing and experimenting with the new multi-stage turbine turbodrill. But it was not before the eve of the last war that these technicians succeeded in constructing a turbodrill which developed greater power, had a longer servicing life, and was capable of drilling at lower depths. The turbodrill constructed by Shumilov in 1939 was named T-10-100 and was used for drilling holes of 11¾ inch in diameter and larger. It had a diameter of 9¾ inches, a length of 26 feet, 8 inches, and weighed 4,848.8 pounds. It had 96 pressure stages, 29 blades, and a computed diameter of 7¼ inches. (See Figure 3, page 86.)

Model T-10-100 was used only for experimental purposes in the Vtoroi region, Baku. Experimental drilling gave the following results on operations at various depths.

	DRILLING DEPTH, FEET		
	UP TO 3,280	FROM 3,280 TO 6,580	FROM 6,580 TO 9,840
Turbodrill power, hp	324	270	235
Fluid flow rate, Gpm	888	745	650
Pump Pressure, psi	1,470	1,470	1,470
Rotation speed, rpm	600	600	600
Height of the blade, inches	1.0630	0.8661	0.7480

Model T-10-100 had to be discarded because of the rapid deterioration of the upper pressure bearing. The screwed assemblage between the body of the turbodrill and the upper connection was also quickly deteriorating.

The next model, the T-12, succeeded in improving partially the defects of the first. In spite of this, however by 1940-41, the turbodrill was still far from being a practical drilling tool.

Figure 1. Diagram of the stator and rotor of Kapelyushnikov's "turbobur."

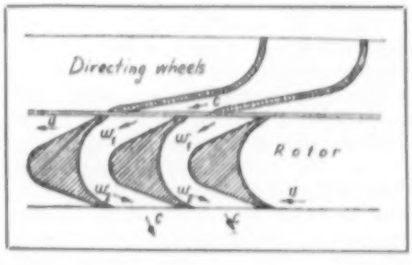
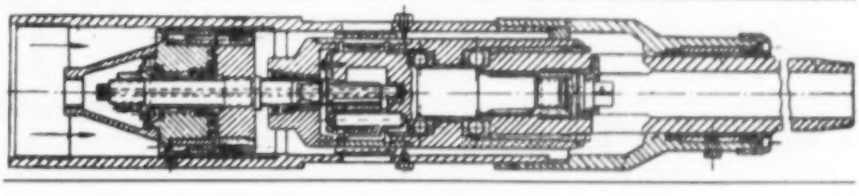


Figure 2. Kapelyushnikov's original "turbobur" with one-stage turbine, built in 1924.



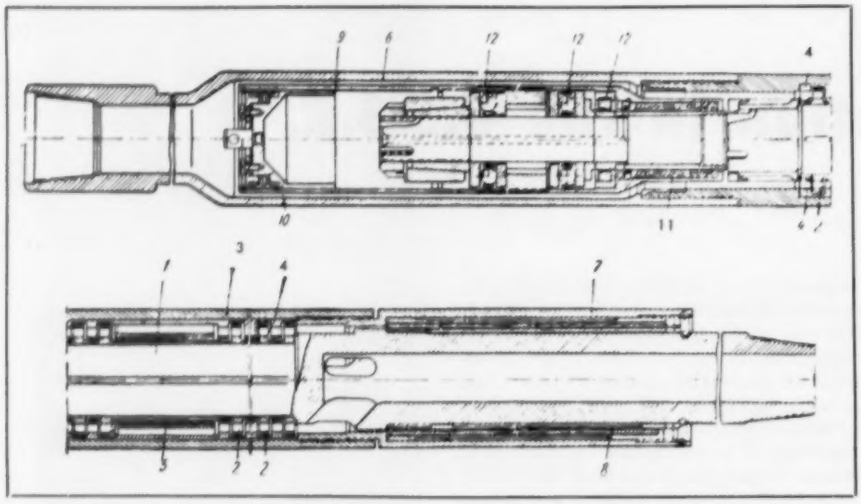


Figure 3. Model T-10-100. 1) The arbor, on which are wedged 2) the 96 disks (rotors). 3) The body of the turbodrill. 4) The guiding wheels (stators). The rotors and stators are made of malleable cast iron. The blades are manufactured of section iron. 5) The central stand which supports the turbine's long arbor in order to prevent bending. The lower part of the arbor is cored, and provided with a nozzle through which the mud is jetted to the bit. The upper part of the turbodrill's body is assembled, through a screw thread, with 6) the coupling, through which, in turn, the turbodrill is articulated to the drill pipe. 7) The nipple with 8) the guiding case, on which is fixed a bushing made of vulcanized rubber. The lubrication mechanism inside the 9) lubricator's cylinder is a 10) hoop piston. Lubricating oil is fed in beneath the piston. While the turbodrill is in action, the piston is brought to bear with a heavy hydraulic charge, under which it slides gradually, and presses the lubricant into the bearing. In order to avoid the mud stream penetrating into 12) the ball and roller bearing gear, on which is suspended the arbor, the mechanism has been rendered watertight by means of 11) a stuffing box.

The last model constructed in Russia—about which information and technical data are available—is the turbodrill T-14-100. A simplified sectional view is shown below in Figure 4.

The difference in construction between T-12 and T-14 lies particularly in the fact that the bearings of the latter have been replaced by a multistage pivot provided with a rubber liner. The pivot is formed of disks which rotate with the turbodrill's arbor and a fixed system of pivotal thresholds covered with rubber which are fastened to the turbodrill's coupling. The multistage pivot absorbs the axial thrusts generated on the arbor and, at the same time, its stages serve also as radial bearings.

The latest model has up to a hundred pressure stages, each one formed by a stationary guide wheel and a revolving wheel. The multiplicity of the pressure steps permits the imparting to each rotor blade of only a fraction of the generated power. The velocity of the fluid stream flowing through the guiding and revolving wheels is, for this reason, noticeably reduced (to between 53 and 66 feet a second).

The new model develops a power of 120 to 150 hp, at a turbine spindle rotation speed of 300 to 600 rpm. It is so constructed as to be capable of rotating the drilling bit without the help of reduction gears. The absence of such gears allows the bit to be kept on the floor longer and increases the efficiency of the drill.

The lower fluid velocity permits covering the stationary and rotating elements of the turbine with a thick rubber lining, thus insuring a longer life for the turbine blades.

Also, the bearings in the latest model have been subjected to change. The axial effort of each pressure stage is transmitted to the respective disk of the stator, and the annular rubber ligament which separates the stator from the rotor serves also as axial bearing for each of the multiple pressure stages. This distribution of the axial effort eliminates the use of axial ball and roller bearings, and relieves the arbor of the load. This system has, of course, shown good results in the Reid pump. Its inconvenience lies, however, in some reduction in the degree of efficiency of the drilling tool.

In addition, the lubricating system has been radically changed. Inasmuch as the steel ball bearings have been replaced by rubber ball bearings, and all the parts which rub against each other while in motion are rubber lined, there is no longer any need for special lubrication; the drilling fluid fulfills the lubricating function.

As a result of the increase in the number of pressure stages, the T-14 model is capable of developing sufficient power for drilling purposes, even for drilling holes of a larger diameter.

The T-14 model is produced in Soviet Russia in the following sizes, for borehole diameters indicated:

TURBINE DIAMETER	BOREHOLE DIAMETER
9¾ inches	11¾ to 27¾ inches
7¾ inches	9¾ inches
7 inches	9 inches
5¾ inches	7¾ inches

A detailed view of the T-14-100-9¾ inch model turbodrill is shown on page 87.

The operating data of the T-14-100 turbodrill are as follows:

	9¾ INCH	7¾ INCH	7 INCH
Fluid flow rate, gpm ..	634	475	349
Effective power, hp ..	180	100	55
Arbor rotation at maximum of power, rpm	600	685	665
Torque, lb. per sq. ft.	42.0	21.5	12.29
Turbine:			
Fall of pressure, psi	882	808	588
Outside diameter, inches	9.842	8.070	7.089
Length, feet	24.689	24.115	21.146
Weight, pounds	4,849	2,865	2,205

● Constructors of the drilling turbine had to solve a complicated technical problem; to create a powerful hydraulic motor of a small diameter, with a low rotation speed, capable of developing 100

Figure 4. Sectional view of turbodrill model T-14-100. (Measurements shown are in millimeters.)

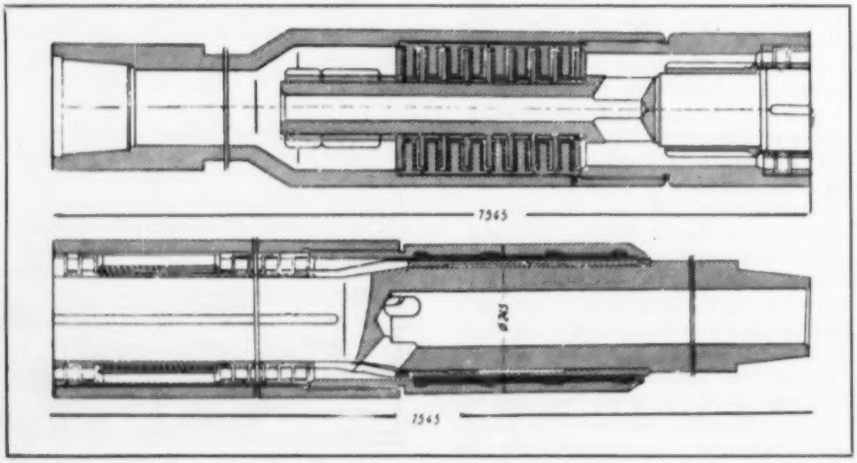
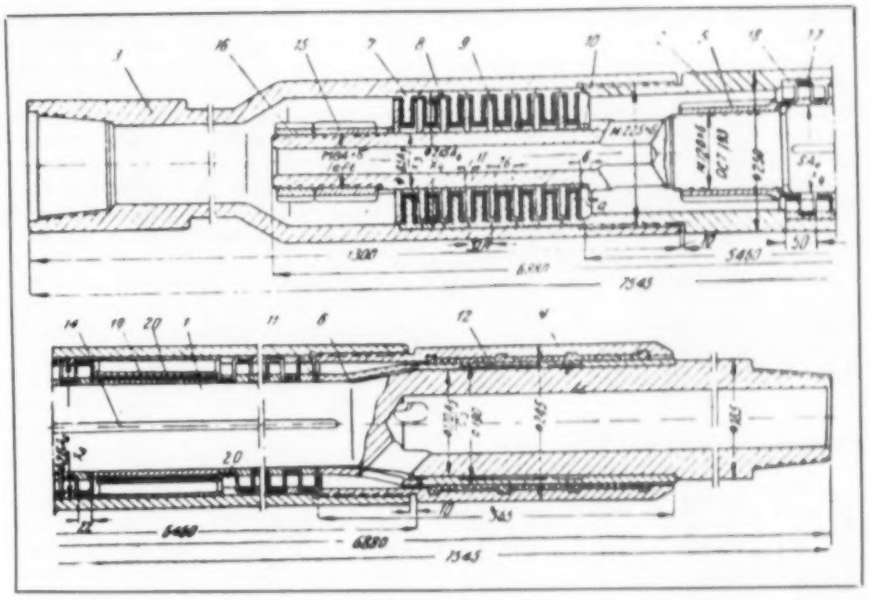


Figure 5. Model T-14-100-9¾". 1) The arbor, enclosed in a 2) tubular shell, called a carcass. 17) One hundred rotor disks (96 for smaller diameters) attached to 18) the stator disks (guiding wheels) are fastened on the carcass. At the lower part of the carcass is tightly fastened 4) the nipple, which fulfills the role of a rubber bearing. The nipple hampers the loosening of the guiding wheels. On the upper part of the drilling tool is attached 15) the nut and 16) the lock nut of the rubber bearing, consisting of 8) ten joint rings and 7) ten rubber stands fastened on the arbor. They absorb the axial efforts generated within the turbine. The fluid reaches 3) the reduction gear of the drilling tool. Thence it passes through the cored upper part of the arbor, leaves through the lateral windows disposed arborwise above the first guiding disk, and enters into the turbine, which it sets in rotary motion. Beneath the last disk, the drilling fluid flows back into the cored arbor through the lateral windows, and thence is drained through the holes in the bit.



to 200 hp at the arbor and to use for power generation purposes the drilling fluid, circulated with maximum charge and at a relatively reduced flow rate.

For purposes of definition, the turbodrill is a slow hydraulic engine. Among modern reaction turbines, it has the lowest specific rotation value: while the specific rotation value of the four types of the Francis turbine, for example, ranges from 50 to 400, and that of the Kaplan helicoidal turbines from 400 to 1,200, the rotation speed of the multistage drilling turbine varies between 6 and 15.

The speed coefficient of the rotors of an axial reaction turbine of the types presently used in the construction of turbodrills varies between 100 and 200.

The graphic design reproduced below shows a longitudinal section of the blades of a 12-inch turbine. In this turbine, the revolving blades are the anti-symmetrical image of the guiding blades. This setting places the rotor blades under equal working conditions, each one bearing the same load distributed by the circulating fluid stream. The rotor bears a pressure drop of approximately 6½ feet. At a flow rate of 800 to 870 gpm, it produces 1 to 1½ hp per pressure stage. Consequently, the turbine must have approximately 100 stages in order to be able to generate sufficient power for drilling purposes.

For a better understanding of the physical phenomena which occur in the interaction between the rotor blade and the fluid jet, one should imagine that the turbine's guiding and revolving wheels are similar to a hydrodynamic network, formed of isolated aerodynamic profiles, and that the rotor network is the virtual image of the stator network. The turbine's blades are absolutely equal, and similar to the aerodynamic profiles used in the construction of airplane wings. The principle underlying these profiles aims at creating great propellent forces and small frontal resistances when a fluid flows about an airfoil.

Figure 7 represents a hydraulic profile network in a static position while the fluid flows about the axial stator.

The mechanics of the turbodrill can be briefly explained as follows: the axial, multistage hydraulic turbine is actuated by the drilling fluid, ejected by a piston engine pump. The fluid passes through the throttle valve and flows into the carcass to the radial and axial bearings of the main arbor. The drilling fluid imparts a rotary motion to the turbine while flowing through each of its successive stages. The fluid flows off the turbine, runs through the shaft and is jetted against the bottom of the hole through the holes in the bit.

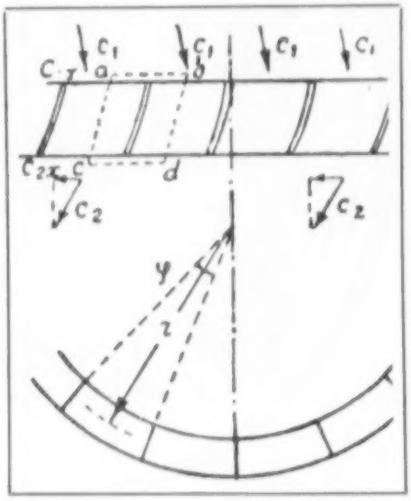
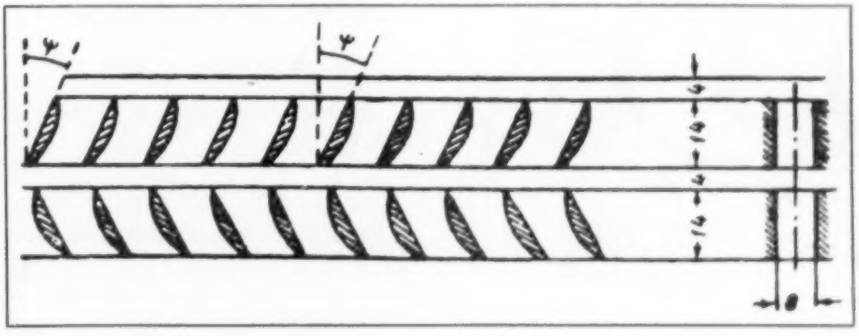


Figure 7. Schematic representation of a hydraulic profile network in a static position while fluid flows about an airfoil.

Figure 6. Longitudinal section of the blades of a 12-inch turbine.



The main difference between the function of a turbine and that of a pump consists in the fact that, in the former, the fluid releases energy to the rotor blades and thereby sets them in motion. The essential element in the process of energy transmission is the interaction between the blade and the fluid stream. The piezometric energy is changed into kinetic energy in the stator's channel.

When leaving the stator's channel, the circulating fluid stream acquires a signi-

ficant rotation speed about the axle of the turbine.

The reaction moment on the rotor's blade is opposed to the moment generated on the stator blades. Under its influences, the rotor revolves with the arbor about the latter, and performs the useful work.

Inasmuch as the pressure loss of the fluid is equal at each of the turbine's stages, the value of the torque is equal as well at each of the individual stages. The torque on the arbor, therefore, equals the sum of the torques at these equal stages. The torque reaches its highest point when the drilling fluid is thrust out of the turbine.

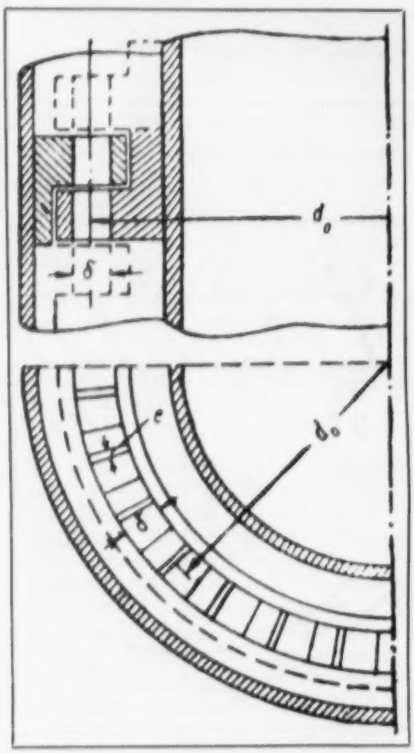


Figure 8. One of the turbodrill's steps.

Under normal operating conditions, the fluid strikes the rotor blades "without shock," that is, at this moment there does not occur an abrupt variation in speed caused by the loss of energy through shock. Consequently, the losses of energy caused by fluid shock in a normal operation are, theoretically, nil. Such a condition is distinguished by a specific torque at the arbor. Any variation in the fluid pressure causes a variation in the rotor's angular velocity. This in turn alters the operating condition of the turbine. Any variation is mirrored in, and influences, the velocity of the fluid jet at the inlet and exit of the motor. Consequently, an operational analysis of the turbine could be made through a study of the triangle of velocities of the fluid jet entering and leaving the turbine.

Under abnormal operating conditions, in which the fluid jet penetrates upon the blades "with shock," the turbine functions in a different manner. The force applied on the arbor differs from that indicated by the theoretical calculation of the angular velocities under normal conditions. A change in the value and direction of velocity alters the triangle of velocities, and the fluid jet "crumples" when it strikes the blades. This deflection causes a loss of energy, the value of the loss increasing according to the degree of deflection of the fluid jet from its normal angle.

The efficiency of the drilling turbine is, therefore, improved if the fluid flows smoothly and without great variations in rate. The latter causes variations of bit load and, consequently, of bit speed.

• The turbine's hydraulic capacity is calculated by determining the type of rotor, the number of pressure stages, the main dimensions of the turbine and its parameters of functioning. It is obvious that all dimensions of the outfit must harmonize so as to secure the highest efficiency in the turbodrill. Due to the great number of values which must be determined, there are also many methods of computing the turbine's hydraulic capacity as well as its useful load. Some of these methods follow:

Let Q = the flow rate of the drilling fluid.
H = the pressure
n = the turbine rotation speed
N = the turbine power

Then the flow rate is directly proportional to the number of revolutions of the turbine:

$$\frac{Q_1}{Q_2} = \frac{n_1}{n_2}$$

The pressure drop in the turbodrill is proportional to the square of the number of revolutions of the turbine, or to the square of the flow rate:

$$\frac{H_1}{H_2} = \frac{n_1^2}{n_2^2} = \frac{Q_1^2}{Q_2^2}$$

The power of the turbine is proportional to the cube of its own rotation speed, or to the cube of the flow rate:

$$\frac{N_1}{N_2} = \frac{n_1^3}{n_2^3} = \frac{Q_1^3}{Q_2^3}$$

The value of the torque at the arbor varies proportionally with the square of the flow rate:

$$\frac{M_1}{M_2} = \frac{Q_1^2}{Q_2^2}$$

Or, in another method:

Let k = the number of stages of the turbodrill,
Q = the flow rate of the drilling fluid in liters per second,
p = the pressure drop on one stage of the turbodrill, expressed in kg/cm^2,
H = the pressure drop on one stage of the turbodrill in the fluid jet,
N = the power of the turbodrill, expressed in hp,
M = the torque on the arbor, expressed in kgm,
D = the diameter of the drill, in m,
P = the peripheral stress on the drill, in kg and
η = the efficiency of the turbodrill.

Then the power of the turbodrill will be:

$$N = \frac{kQp\eta}{7.5} = \frac{kQH\eta}{75} \text{ hp}$$

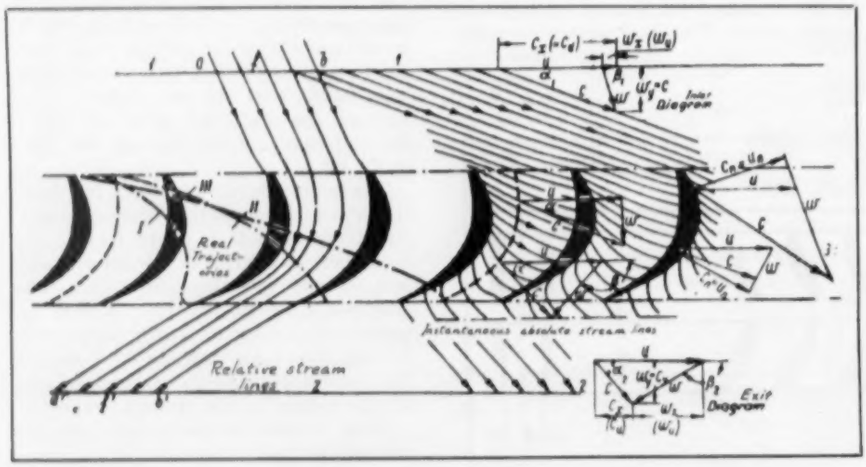
The torque on the arbor will be:

$$M = 716.2 \frac{N}{n} \text{ kgm}$$

And the peripheral stress on the drill will be:

$$P = \frac{2M}{D} = 1{,}432 \frac{N}{Dn} \text{ kg}$$

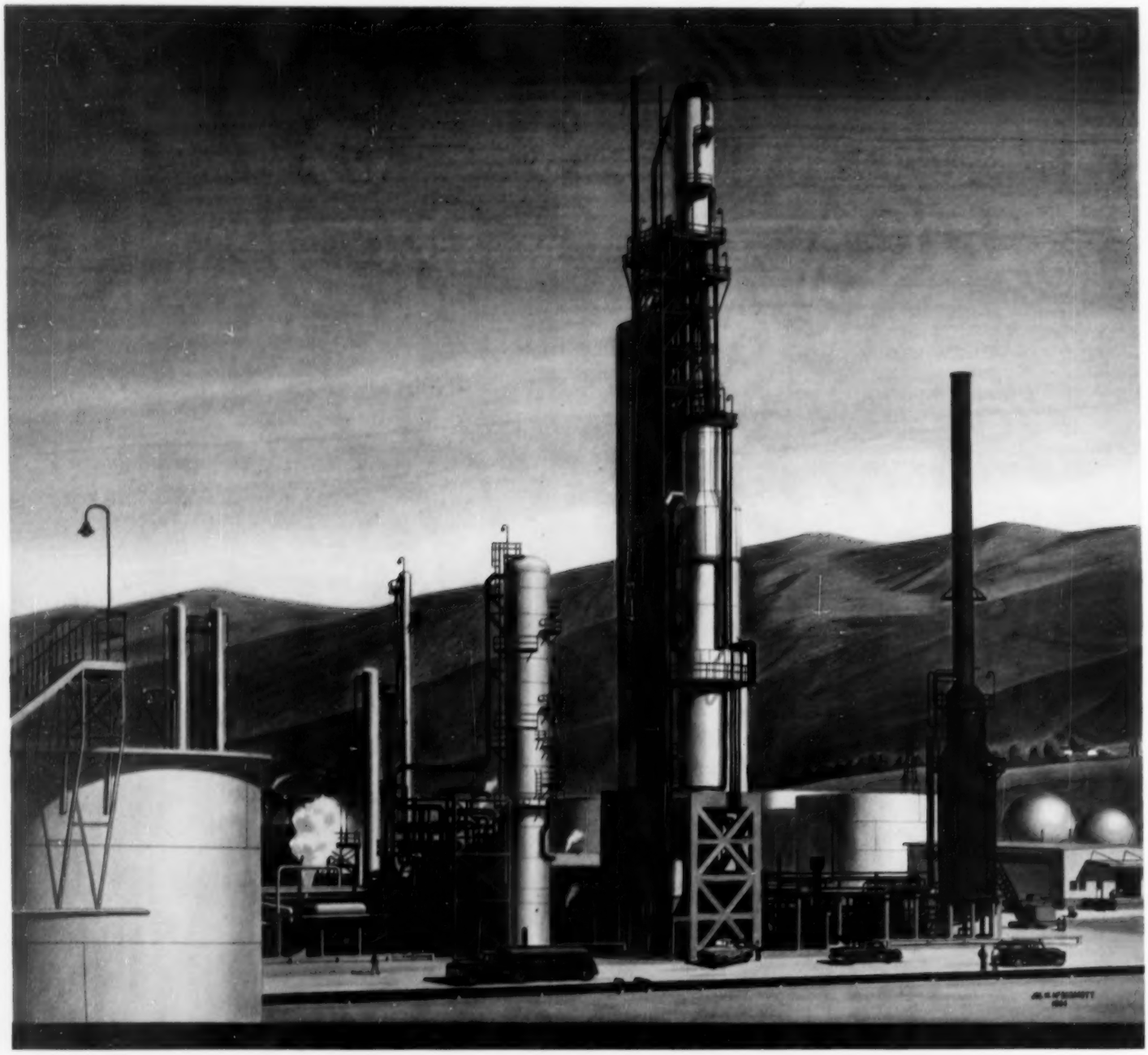
Figure 9. Flow scheme around the rotors' mobile network.



Part II of Mr. Rosu's article in the April issue will deal with the drilling fluids and pumps required by the turbine drilling method, together with an examination of some of the operating results.

NO JUNGLE TOO IMPASSABLE....

WHEREVER THE DRILL GOES.....
..... SCHLUMBERGER GOES!



SALT LAKE REFINERY

The Houdriflow Catalytic Cracking Unit of the Salt Lake Refining Company has been consistently handling charge rates well above the 13,000 BPSD design reactor charge rate since going on stream in 1950. In 1952 this installation served as a test unit for studies in catalyst travel. Radioactive beads were introduced into the reactor, and their subsequent movements were checked by Geiger counters. These tests proved that the catalyst circulated through all parts of the Houdriflow unit with excellent uniformity.

Houdriflow units are now operating at the highest conversion levels ever achieved in the industry. An informative new brochure describing the Houdriflow process is available on request. Write to: Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa. International licensor: World Commerce Corporation, S. A.

HOUDRY
PROCESS CORPORATION
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Dually-Completed Wells

(Continued from page 69)

where the operator desires sub-surface protection to prevent wild, uncontrolled flow in case of damaged surface connections or other operating failures. Such installations consist of a standard Otis sub-surface safety valve attached to the lower end of a cross-over flow choke. The lower zone production is directed through, and controlled by, the safety valve cage assembly before the choke crosses the flow into the tubing-casing annulus. Another landing nipple is made up above the cross-over installation in which a regular Otis tubing safety valve is seated. This affords protection for the upper zone (having been crossed into the tubing, also by the cross-over choke). In the event of a surface emergency, the sudden increase in pressure differential across the safety valve will cause it to snap shut instantly and close in the well until surface repairs are made and the valve is reopened and production resumed.

Although the majority of dual completions are flowing under natural pressure, the scope of two-zone production equipment is not restricted to these wells. Also available are sucker rod pumps for dually-completed wells (Fig. 1) which Otis marketed several years ago. The installation and operation of this equipment has many of the same desirable production features as the various other tools for producing dually-completed flowing wells. In actual production practice, a two-zone rod pump installation can be operated with the same advantages, cost-wise, and enables operators to continue the exploitation of two oil zones even after reservoir pressures have been exhausted. The installation of a two-zone pump does not require the use of an additional pumping jack or other surface equipment, nor are additional sucker rods required. A second flow line fitting must, of course, be made up as the casing outlet, but the operation of the pump itself does not require an additional stuffing box, polished rod, or other special fittings such as flexible lines, duplex polished rod grips, or the like. As a general rule, operation of a second sub-surface pump increases the load on the rods and prime mover only about 25 percent, and usually the addition or adjustment of the counterweights on the walking beam is all that is necessary to pump the second zone.

The two-zone pump consists of an assembly of two pumps made up in tandem. One pump produces the upper pay and the other pumps the lower zone. In most installations a positive-displacement tubing pump is used to pump the upper zone and a rod (insert) pump to produce the lower zone. The pumps operate in conjunction with an annular style cross-over packer, a pack-off unit that separates the upper and lower zone fluids within the packer body and a string of rods between the two pumps which are carefully tallied to space the upper and lower plungers properly within their respective working barrels.

A packer must be used to separate the pays in all dually-completed wells. Although it is not considered as part of the downwell pumping equipment, it is important that the packer have certain mechanical features in order to obtain efficiency in dual pumping. No movable parts within the packer should move during the pumping operation, the pack-off elements should afford a positive set with very little or no load being applied from the weight of the tubing string, retaining slips should have a large gripping area against the casing wall, and the packer bore should be unrestricted, with the I.D. being at least equal to the O.D. of the tubing in the well. There are a number of packers on the market which fulfill all of these requirements.

Much has been written about the new "permanent" method of completing wells. With this procedure the tubing and wellhead are installed only once in the life of the well (while the rig is still on the location) and all completion and subsequent remedial operations are performed with wire line tools and equipment. The new method has many advantages for single-zone wells, and since the process works equally well, if not better, in the lower zone of the two-zone wells, operators contemplating dual well programs should follow its progress closely. Virtually all of the operations and equipment described in this article can be accomplished in one way or another in permanently-completed dual wells.

Operators in South Texas were among the first to dually-complete oil wells about 1936; in California's Montebello field in 1939, around 100 two-zone wells were brought in, and subsequently dual-completions were producing in the Long Beach Harbor area and in the Paloma, Riverdale, Coalinga, and other fields. Operators in southeast Texas and along the Gulf coast later began dually-completing deep wells and today dual-completions can be found in almost all areas in the mid-continent and Gulf coast. The Kansas commission authorized dually-completed wells in the Candless field, and operators in Canada are watching Gulf's experimental dual-completion wells in the Stettler field.

There is no doubt that these are the days of dual-completions. Production practices have been perfected to the extent that two-zone wells are here to stay.

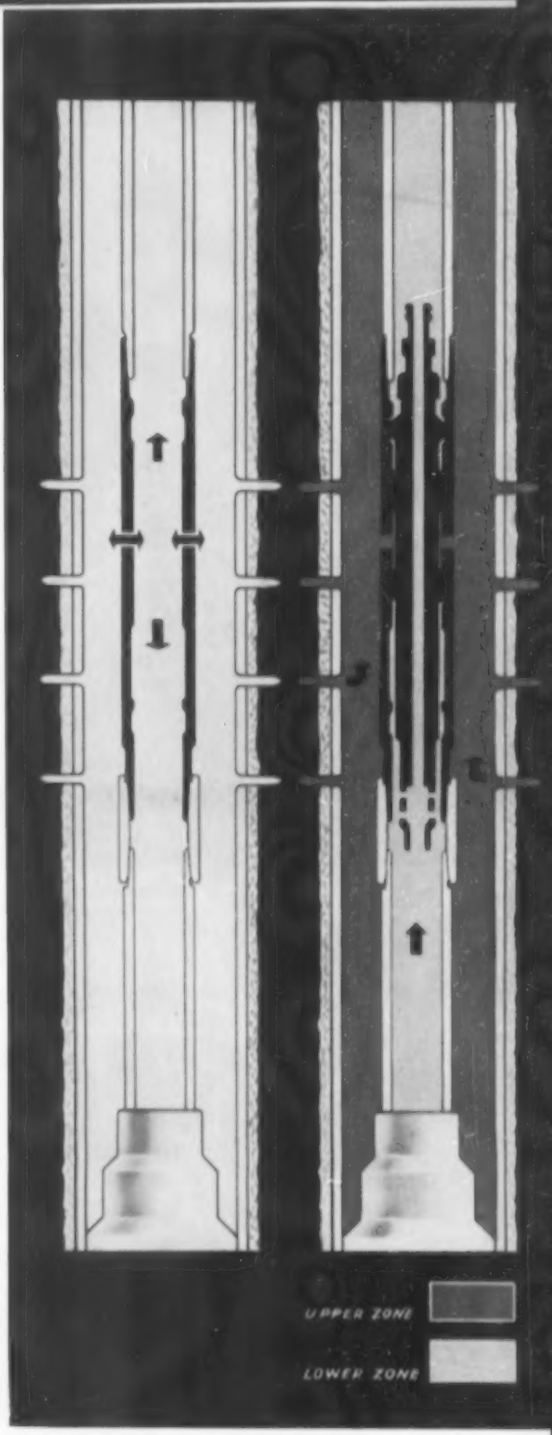
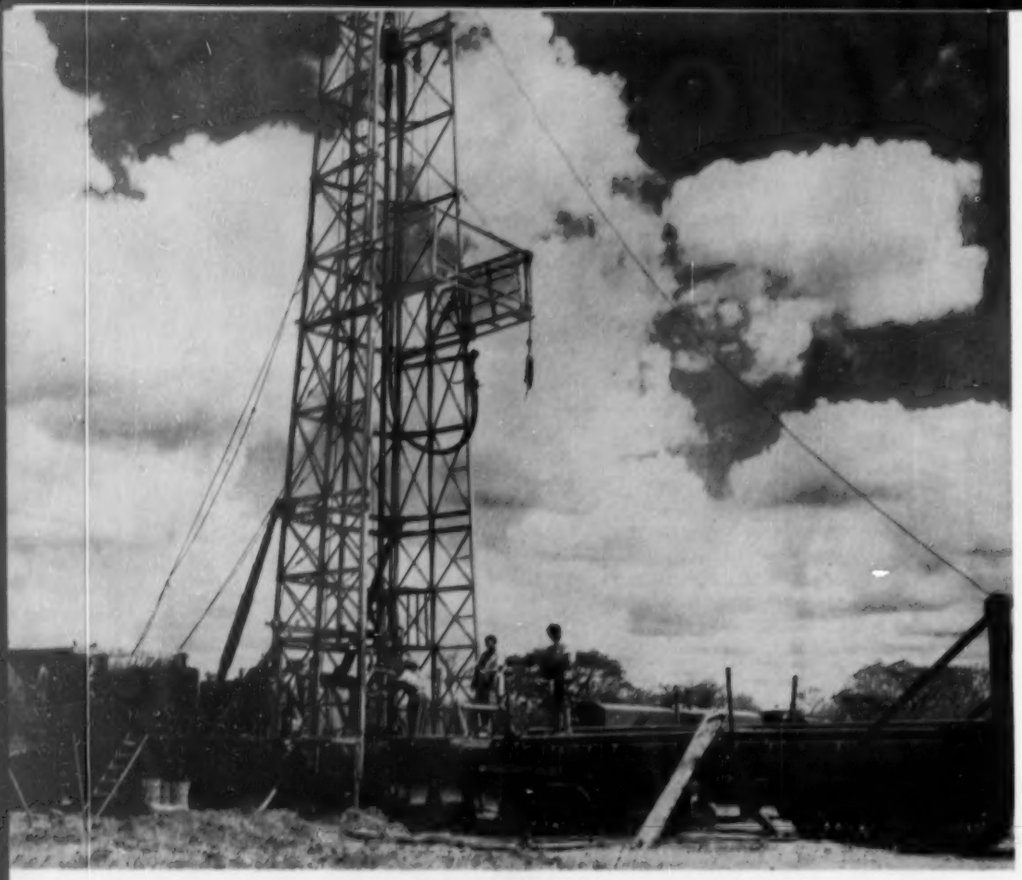


Figure 5
Principle of the Otis method of (1) establishing a horizontal flow course between the tubing and tubing-casing annulus above the packer, and (2) providing a means of opening and closing the flow course as desired. The communication is effected by the side ports in the nipple (hence the term "side-door"), and the removable tool which packs off around the parts.



Track-mounted Cardwell rig used to drill 6,000-foot holes in Mene Grande's "strat test" program.

Exploration

LAST YEAR was a record year for wildcatting in Venezuela. While overall completions declined about 14 percent to 811, wildcat completions were up four percent to 152, more than in any previous year. Twenty-one new fields and 46 new pools were discovered.

Seismograph was used in surface exploration at an unprecedented rate. From an average for the year of 35 parties of all types, seismograph parties averaged about 19. As a result, while surface exploration was off in terms of party-months, in terms of dollar expenditure it was practically unchanged from 1952 and 1953. Guarico, Anzoategui, Zulia, Monagas and Falcon, in that order, were the states where wildcatting was

A seismograph crew at work on open savanna country typical of the Greater Oficina area.

Reading the gravimeter.

Tamping a seismograph shot hole in rugged terrain. Note chains on dual wheels of shooting truck.

"Fire in the hole!"

active in VENEZUELA

heaviest throughout the year. Barinas, Apure, the Delta Amacuro and Trujillo accounted for a handful of exploratory wells.

No major new oil provinces were opened (nor are likely to be until new concessions are authorized). The most noteworthy of the year's wildcats were new-field discoveries which expanded the Greater Oficina area beyond its previous margins, and new-pool finds in the Bolivar Coastal fields and Lake Maracaibo.

The trend toward increased wildcatting in Venezuela has been very marked in the past two years. Wildcats accounted for only seven percent of all completions in the four years 1949-52, doubled to 14 percent in 1953 and in 1954 represented 18.8 percent of all completions (see Table I).

Almost three-quarters of the 1954 wildcats were drilled in Eastern Venezuela. Wildcatting is a more risky proposition in Eastern Venezuela, with a 40 percent success ratio in 1952, than in Western Venezuela, where the ratio last year was about 60 per cent.

These success ratios, very high when compared with those of the United States ratios, are due to special conditions existing in Venezuela. The principal difference is that in Venezuela acreage is acquired from the government in large blocks, with moderate rentals and taxes, for a long period of time, currently 40 years. The result is that the pressures of time and competition are much milder in Venezuela, and there is adequate time for thorough study before drilling.

For purposes of comparison, Table II shows the results of all drilling, wildcat and development, in 1952. Success in Eastern Venezuela was about 80 percent and in Western Venezuela about 90 percent.

The higher success ratio in Western Venezuela is due in part to the higher proportion of field wells drilled there, as compared with Eastern Venezuela (see Table III).

Total rig-time has declined gently in Venezuela, about three percent per year in 1953 and 1954, and with a slight

A typical seismograph camp set up among liana-festooned trees.

Wildcat rig on the Rio de Oro, international boundary between Venezuela and Colombia.

Seismograph detector planted for rigidity in the swamps of the Delta Amacuro.

TABLE I
WILDCAT COMPLETIONS BY YEARS

Year	Total Wells	Wildcats	% W.C.
1949	682	50	7.3
1950	663	43	6.5
1951	1,205	93	7.7
1952	1,312	98	7.5
1953	945	134	14.2
1954	811	152	18.6

TABLE II
ANALYSIS OF TOTAL COMPLETIONS*

	Eastern Venezuela	Western Venezuela	Total
Oil	407	263	670
Gas	9	0	9
Abd.	105	27	132
Total	521	290	811
% of Country	64.2	35.8	100.0

*Not including 29 suspensions.

TABLE III
WILDCAT EFFORT, BY MAJOR AREAS

	Eastern Venezuela	Western Venezuela
Total Wells	521	249
Wells Completed	111	41
% Wells Completed	21.3	14.0

TABLE IV
RIG-MONTHS BY YEARS

	1952	1953	1954
Total Months	1,339	1,300	1,249
% Change	...	—2.9	—3.9
Wells Completed Rig-Months	n/a	383	32
Average Wells Completed Rigs	...	32	29

TABLE V
WILDCAT COMPLETIONS PER MONTH

Year	Wildcats	Wells Completed per month
1949	50	4
1950	55	5
1951	93	8
1952	98	8
1953	134	11
1954	152	13

TABLE VI
PARTY-MONTHS OF SURFACE EXPLORATION BY TYPES

	1952 Months	%	1953 Months	%	1954 Months	%
Surface geology	224	45.0	222	45.0	147	35.0
Seismograph	205	42.0	215	43.5	221	52.6
Gravimeter	38	8.0	40	8.0	37	8.8
Structure Drill	25	5.0	17	3.5	15	3.6
Total	492	100.	494	100.	420	100.
Cost (Thous. $)	$15,430		$15,650		$15,485	

TABLE VII
GEOGRAPHICAL BREAKDOWN OF PARTY-MONTHS

	Total 1954 Party-Months	% of Country	% in 1953	% in 1952
Eastern Venezuela				
Anzoategui	51	12.1	17.0	13.5
Guarico	34	8.1	9.0	11.0
Monagas	76	18.1	13.5	7.0
Other	2	0.5	2.0	1.5
Sub-Totals	163	38.8	41.5	37.0
Western Venezuela				
Barinas Basin	99	23.6	19.0	20.0
Zulia	76	18.1	12.0	11.0
Falcon	32	7.6	8.5	15.0
Mountain States	50	11.0	18.0	15.0
Other	..	..	1.0	2.0
Sub-Totals	257	61.2	58.5	63.0
Grand Totals	420	100.0	100.0	100.0

TABLE VIII
VENEZUELAN PRODUCTION BY OPERATORS
Daily Average Operated Production

	1952	1953	1954*
Creole	767,384	747,764	761,572
Shell Co.'s	551,740	507,940	564,141
Mene Grande	313,857	327,701	352,216
Socony	57,998	64,521	66,098
Texas Co's.	43,999	43,916	56,012
Richmond	19,531	20,313	34,431
Atlantic	17,365	18,372	20,600
Sinclair	12,957	16,229	20,187
Phillips	10,302	9,058	7,973
Pantepec	8,601	9,516	9,267
Talon	938	975	1,222
Totals	1,804,872	1,765,855	1,893,719

*December estimated.

decrease in the proportion of wildcat as compared with development rig-time. The 152 wildcat completions of 1954 were accomplished with an average of 29 rigs, as against 32 rigs needed to complete 134 wildcats in 1953 (see Table IV).

In view of the decline in rig time, the increase in the rate of wildcat completions, from four per month in 1949 to 13 per month in 1954, is rather surprising (Table V). Data are not available to indicate whether this is due to some such factor as shallower drilling, or to general increased efficiency in wildcatting.

Another important index to exploratory effort, surface-party activity, is itemized in Table VI. The number of party-months declined in 1954 about 15 percent from the 1953 total.

However, in terms of money expended, the difference between 1953 and 1954 was negligible. While party-months of surface geology declined to about one-third of the total, the much more expensive seismograph party-months rose to more than half.

Monthly costs of surface geology can be conservatively estimated at about $5,000, seismograph at $60,000, gravimeter at $20,000 and structure drill at $50,000. Applying these figures, the total bill for surface exploration has varied little from $15.5 million in the last three years.

Percentage distribution of field parties between Eastern and Western Venezuela has varied little in the past three years, but the detailed geographical breakdown of Table VII shows how different areas have waxed and waned in attraction for the operators. The state of Monagas, for instance, drew over 18 percent of party-months in 1954, as against only seven in 1952. The Barinas Basin (states of Apure-Barinas-Cojedes-Portuguesa) continues high in popularity, accounting for almost one-fourth of total party-months in 1954. Interest in Zulia was up in 1954, with over 18 percent of all party-months spent there, but Falcon was down from 15 percent in 1952 to 7.5 percent in 1954 (see Table VII).

The 152 wildcats drilled in Venezuela in 1954 resulted in the finding of 67 new fields and new pools. One operator, Mene Grande Oil Co., was responsible for 23 of these. All 33 of Mene Grande's wildcats were drilled in Anzoategui, most of them in the ever-expanding Greater Oficina area. Zumos-1, Nardo-1 and Nueces-1 (initially separate but now being joined into one field by stepout drilling), Caico Seco CaXZ-203, Linon-1, Lido-1, Nidos-1 and Elotes-1 were among the better ones, all dual-zone producers making from 700 to about 1,000 b/d.

Mene Grande last year adopted a new exploratory tool which is showing excellent results. Their structure-drill program, which had drilled 5.6 million feet in over 3,200 holes from its inception in 1939, was discontinued in mid-year. The track-mounted Cardwell rig was then converted from 3,500 to 6,000-foot capacity, and launched on a "strat test" program of drilling slim holes along the major Guara-Leona fault.

Its purpose is to locate channel sands cut off by faults previously delineated by deep-well seismograph and structure-drill work. At final depth of 6,000 feet, which is reached in a matter of days, an electric log is run and side-wall samples are taken. If production seems assured, casing is run. The "strat test" rig then moves off, and testing and completion are effected by a heavier rig.

The first 15 holes of this program resulted in the finding of three traps which will provide additional drilling locations for the future.

Also in Greater Oficina, Socony made dual-zone strikes with Araibel-1R, East Mata-1R, and West Nipa WNV-51. Texas Co. opened a new field with Mata-8.1. Eastward in Monagas, Atlantic had both successes and dry holes in the Oritupano lots.

In northern Anzoategui, Shell made a producer of Bruzual-2, and Mene Grande of Cason-1, both in virgin territory. Neither find was of great importance in itself, but may lead to something better.

In northern Monagas, Sinclair made a new find in south Santa Barbara, with SB-148. Creole and Pantepec have joined in this play on offsetting acreage.

Of the several wildcats drilled in the state of Guarico, none appeared to be of much significance. Creole's Coporo-1 was said to be a good producer, but it is a long way from existing pipe line and has not been followed up with other wells.

In Western Venezuela, wildcatting was brisk (10 wells) but unrewarding in Falcon. In Zulia, new-pool tests drilled by Creole and Shell in Lagunillas and Bachaquero can be assumed to have added considerably to reserves in these older fields. In Mara, several dead Cretaceous producers were deepened into basement rock by four operators, and some were converted into producers of several thousand barrels a day.

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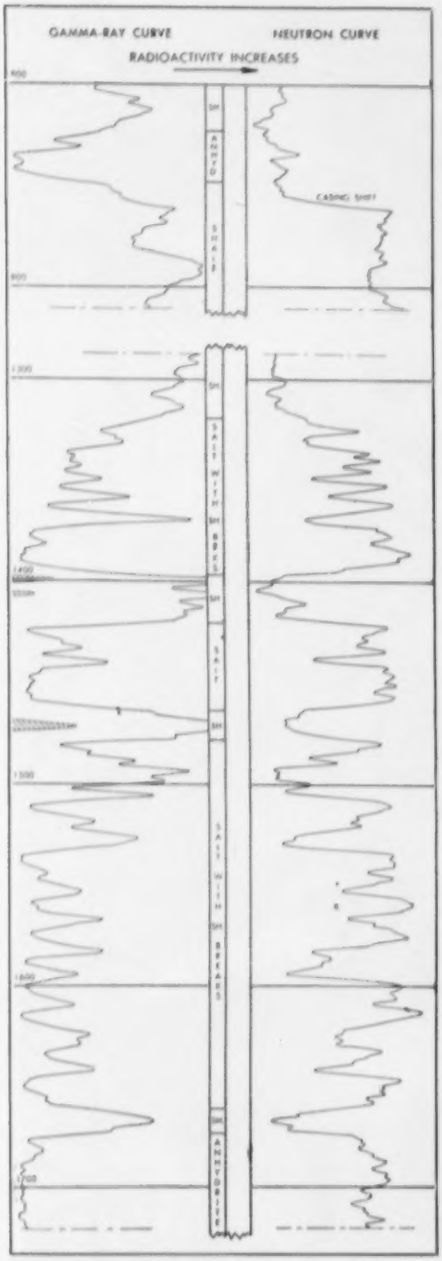


A typical radioactivity log. (Courtesy Lane-Wells Co.)

modulated impulses may be transmitted by radio and recorded in a distant office.

Radioactivity logging: Another milestone in the development of well-logging techniques was reached in 1940 with the introduction of radioactivity logging. Here, again, is a unique system based on a property of earth strata entirely distinct from that used in any other system of logging. All earth formations contain minute amounts of radioactive materials, particularly radium, thorium, and actinium minerals and their derivatives. These materials undergo slow decomposition over geologic time and, in this transformation, energy is liberated in the form of electronic discharges to which the term "radioactivity" is applied. All rocks display some degree of radioactivity, but some more than others, and variations in this property is sufficiently distinctive to afford a means of distinguishing between shales and sands, limestones, salt and other materials frequently present in sedimentary formations. Two types of radioactive emissions are observed in this system of logging, yielding (1) a gamma ray log and (2) a neutron log. A continuous record of these two logs, secured by traversing the well with an instrument sensitive to radioactive emissions, is automatically recorded on surface instruments in the form of two profiles on a chart against a depth scale. The logging instrument usually incorporates an ionization chamber filled with a high-molecular-weight gas, or a scintillometer.

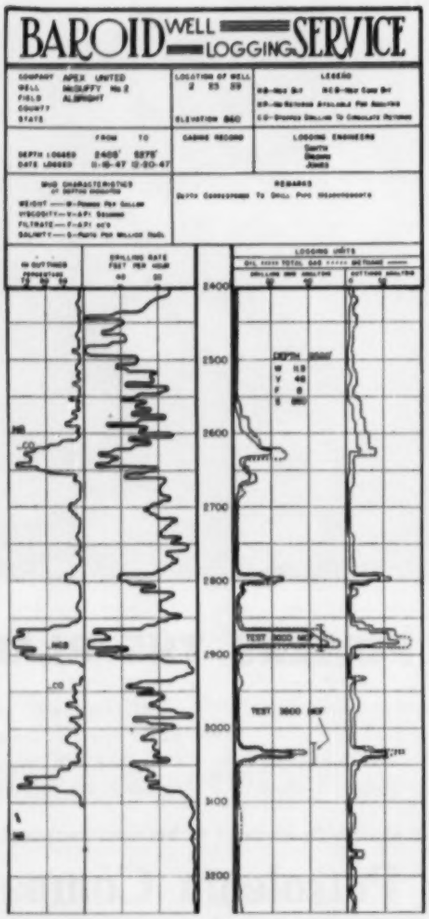
Radioactive emanations are capable of passing through steel and cement and are little influenced by fluids present in the well or by temperature and pressure conditions. This method of logging is therefore particularly useful in identifying formations sealed off behind casing in previously drilled wells for which satisfactory logs of other types are not available. No other system is successful in logging through casing. The neutron log is responsive to variations in the amount of fluid present in the formation (the hydrogen content) and is therefore a useful index of porosity of the strata logged.

Well logging by inspection of the drilling fluid: In drilling wells by the rotary method, drill cuttings and fluids occupying the pore spaces of rock broken by the drill are brought to the surface by the circulating drilling fluid. Close inspection of the drilling fluid as it is discharged from the well should therefore be helpful in identifying the nature of formations in which the drill is operating and of the fluids imprisoned within their pore spaces. A method of logging involving continuous inspection of drilling fluid returns as the well is drilled is gaining in popularity, particularly in drilling exploratory wells where it is important to obtain prompt information concerning formational changes as drilling progresses. Other systems of logging are applicable only after an interval has been drilled.

In this method a service truck containing permanently installed testing and recording devices is located at the well and arrangements are made to divert a representative part of the mud stream for continuous observation. A technologist trained in use of the equipment is stationed at the well. Apparatus in the service truck continuously records a rate-of-penetration graph on a chart, indicating the depth of the well at all times. Ultraviolet light is used to detect fluorescence due to small particles of oil in samples of the drilling fluid, selected at regular intervals for inspection. A hot-wire bridge-type gas detector indicates the presence of suspended particles of natural gas in the mud stream. An instrument that measures increase in the electrical conductivity of the liquid phase of the drilling fluid indicates the presence of saline water in the formation in which the drill is operating. The service truck is also equipped with microscopic and test equipment for inspection of formation samples brought to the surface during the course of drilling. All information gathered in these tests is automatically assembled in the form of a graphic strip log, available for continuous inspection in the service truck.

Geochemical well logging: Knowledge of the fact that hydrocarbon gas leakage often occurs from underground oil and gas reservoirs, resulting in distribution of small amounts of hydrocarbon through the overlying strata, has led to the development of geochemical well logging. In this method of logging, formation samples obtained in the routine of drilling are systematically selected and subjected to delicate chemical tests to determine quantitatively

(Continued on page 98)



A typical log obtained by continuous inspection of the drilling fluid. (Courtesy Baroid Division, National Lead Co.)

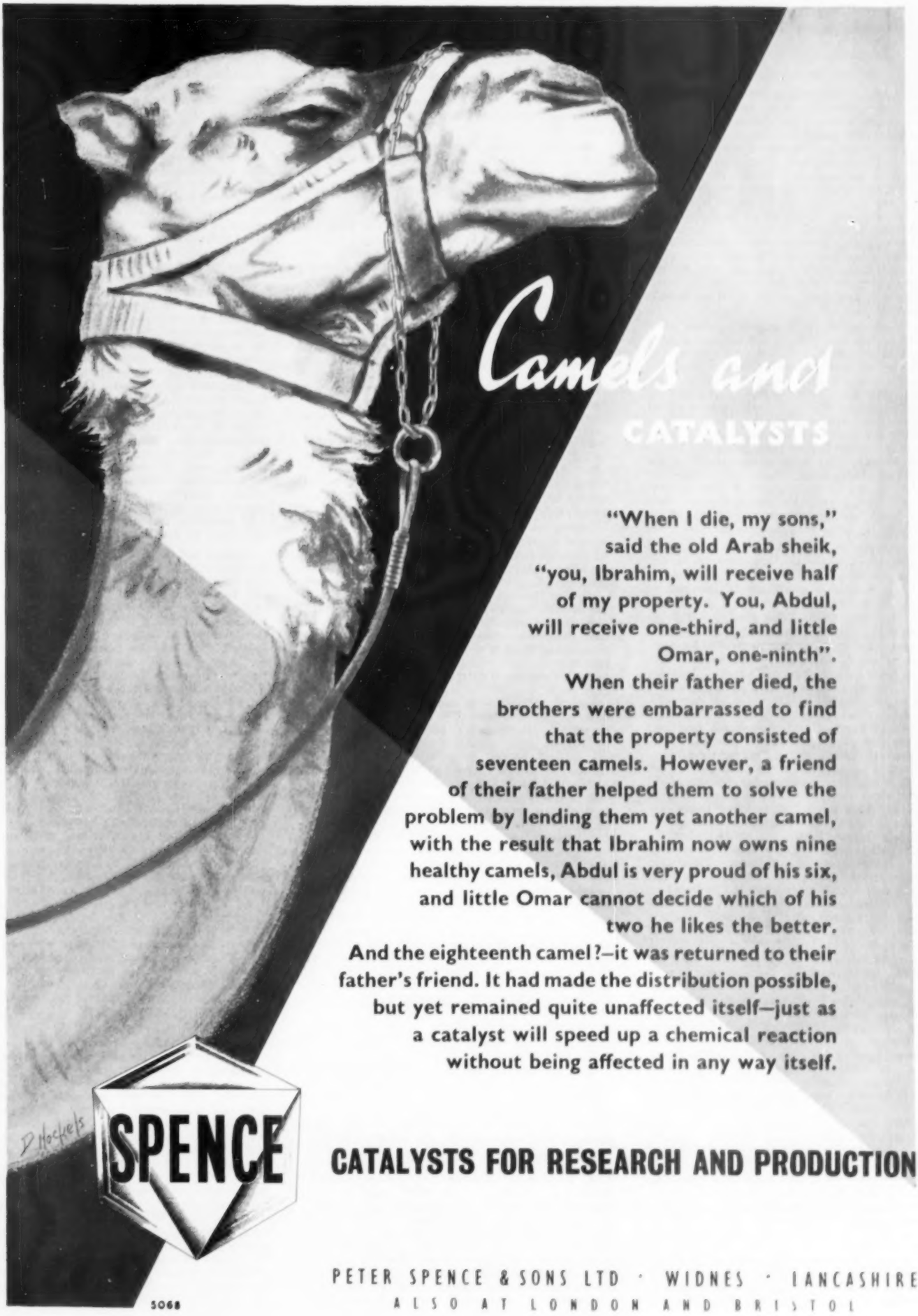
Service truck for mud-logging at a drilling well. Photo Courtesy Baroid Division, National Lead Co.

Well-Logging Techniques

(Continued from page 83)

horizontally. A somewhat similar result is obtained with the "guard electrode" system which concentrates the current in the form of a thin disk extending horizontally into the formation.

Conventional systems of electrical logging depend upon the drilling fluid to conduct electricity between the logging instrument and the wall of the well. For use in measuring formation resistivities when the well is filled with non-conductive oil-base drilling fluid, "induction logging" may be used — an entirely different system for producing and measuring flow of electric current through rock formations surrounding the well. "Frequency modulation" logging employs a unique system for generating, transmitting and recording the electrical impulses created by passage of current through the formation. Instead of being recorded by instruments at the well head, the frequency-


Camels and
CATALYSTS
"When I die, my sons," said the old Arab sheik, "you, Ibrahim, will receive half of my property. You, Abdul, will receive one-third, and little Omar, one-ninth".
When their father died, the brothers were embarrassed to find that the property consisted of seventeen camels. However, a friend of their father helped them to solve the problem by lending them yet another camel, with the result that Ibrahim now owns nine healthy camels, Abdul is very proud of his six, and little Omar cannot decide which of his two he likes the better.
And the eighteenth camel?—it was returned to their father's friend. It had made the distribution possible, but yet remained quite unaffected itself—just as a catalyst will speed up a chemical reaction without being affected in any way itself.
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Well-Logging Techniques

(Continued from page 96)

the amounts of various hydrocarbons contained. As the drill approaches an oil and gas reservoir, a pronounced increase in hydrocarbon content of the overlying strata is often observed. Curiously also, at some distance above the horizon in which the hydrocarbon accumulations are observed, a pronounced "peak" in hydrogen content of the strata is often noted. Such indications are favorably regarded as a promise of an oil and gas reservoir in the underlying formations. Chemical analysis of formation samples may also be extended to include other criteria that are sometimes helpful in correlation studies, such as carbonate, sulfate and chloride content. Results of the chemical analyses are displayed in log form as profiles against a depth scale.

The geochemical well-logging system is of interest as the only one of the various logging methods that indicates directly the presence or absence of oil and gas in formations ahead of the drill. Thus it may have diagnostic value in predicting the success or failure of a drilling operation before the test horizon is reached. Unfortunately, this method of logging is costly and there is necessarily considerable delay after samples are taken before the results of analysis can be known. The method apparently is not universally dependable, possibly because the path of escape of hydrocarbons through the upward. At any rate, the method is not now widely used, although a decade or more ago it appeared to offer considerable promise.

Temperature logging: For some purposes it is important to know the temperature at different depths in a drilling well and instruments have been developed that can be lowered on a cable or wire line to obtain a continuous record of temperature. The geothermal gradient normally shows a fairly uniform increase in temperature of about one degree F. for each 60 feet of depth, but locally the temperature may be more or less than the average gradient would lead one to expect. For example, where gas is expanding as it enters a well from the surrounding formation, a local cool anomaly may be observed. Certain chemical reactions that may occur in or about oil and gas wells may be exothermic and locally produce higher-than-normal temperatures; the setting of cement used in cementing casing, for example. In selecting cement for a cementing operation in a deep well it is important to know the maximum temperature to which the cement slurry will be subjected. Emulsions on photographic films used in well surveying instruments have definite temperature limitations. Expansion and contractions of metals used in casings, pumps, packers and various tools employed in drilling and producing operations will be determined by temperature conditions. Electric log interpretations involve knowledge of well temperatures.

Rate-of-penetration logging: The rate at which the drill progresses in deepening a well is not only of interest from an economic point of view, but it also is an index of the character of formation in which the drill is operating. In soft, easily disintegrated formations, rapid progress is made; in hard strata, or in formations that cave readily or "heave" into the well, progress is comparatively slow. Instruments are available to indicate the rate of progress of the drill, often expressed in feet per hour; and when graphically recorded in chart form the record can often be interpreted in terms of stratigraphy. Correlations of such logs between nearby wells often disclose the dip of the intervening formations.

Caliper logs: Tools are available that can be lowered into and raised through a well on the lower end of a supporting cable, that continuously record the diameter of the well in the form of a log on a depth scale. In rotary drilling, the diameter of the well will often be found to vary considerably with changes in the character of the formation. Through hard formations the gauge of the hole will be but little larger than that of the bit. On the other hand, soft strata may be eroded away by the hydraulic action of the circulating fluid, resulting in formation of cavities about the well or local intervals of over-size hole. Such information is helpful in planning cementing and gravel-packing operations and in the selection of packers. Caliper logs are also helpful at times in correlating formations from well to well.

Formation testing: Information that is properly recorded in the log of the well is obtained by the process of "formation testing." This involves use of special equipment designed to isolate the test interval from overlying and underlying portions of the well bore, reducing pressure within the test interval and securing a sample of the fluid present in the adjacent formation. Formation testers are usually run on rotary drill pipe and their use involves an extra round trip with the drill column. They are a complex assemblage of packers, valves and pressure gauges and while many drillers are sufficiently familiar with them to employ them successfully, most operators prefer to employ a service organization that responds with its own equipment and skilled personnel to make such tests. A successful formation test yields positive information concerning the nature of the fluids present in formations surrounding the test interval, also the formation pressure, and it may even provide a basis for prediction of the rate of oil and gas production to be expected. Having the results of such a test, the operator may decide to equip and complete the well to produce from the interval tested, or to drill deeper in the hope of finding a more prolific producing zone.

Choice of logging methods: Each of the several logging and testing techniques mentioned is unique in some respect and has something to offer that will lead to a more complete understanding of subsurface conditions. However, the specialized services involved in their application are expensive and the owner of a well cannot usually afford to use them all. He will naturally choose among the available techniques those which are likely to yield most information and which promise the most dependable results. Often it will be found advantageous to use two or more logging or testing methods, perhaps with the purpose of checking one against another. The physical conditions presented or character of the formations to be logged will often determine the choice. Mechanical coring is essential when actual formation samples are required for physical inspection, but is expensive and time consuming and is therefore used only where the information needed compels its use. Electrical logging in one or more of its variations is widely used for routine logging of all significant intervals in wells, particularly with the purpose of disclosing potential oil and gas producing strata. The method is rapid and comparatively inexpensive. Radioactivity logging, also rapid and inexpensive, affords a unique basis for determining differences in lithologic character of formations penetrated by a well and may often be used to supplement or confirm data obtained by other means. A very great advantage of the radioactivity logging method is found in its ability to secure a dependable stratigraphic record through casing and cement, or in wells that are empty or filled with nonconductive or highly saline drilling fluids. Interesting possibilities are presented for correlation between electrical logs and radioactivity logs.

Mud logging has the advantage that data are obtained concurrently with the progress of drilling, so that arrangements may be made to take cores or make formation tests before a possibly productive horizon has been drilled through and mudded off. No rig time is lost, for the logging is done while drilling is in progress. Geochemical logging is not widely used because of its high cost and delay incidental to shipping formation samples and awaiting the results of tedious analyses. Temperature logging is particularly helpful in distinguishing strata yielding dry gas from those which yield oil to a well, and a knowledge of temperature conditions is essential in connection with other logging techniques and drilling operations. Caliper logging finds its principal application in connection with well cementing operations. Rate-of-penetration logs provide a useful basis for measuring the efficiency of drilling equipment and personnel under different conditions. Formation testing is widely practiced as a means of securing dependable information on the oil and gas producing possibilities of potential producing zones, and is particularly helpful in wells drilled for exploration purposes.

Looking back from the vantage point of today toward the horizon of yesterday, it is clear that remarkable progress has been made, particularly during the past two decades, in improving well-logging techniques. The talents of some of the world's foremost scientists and many of the petroleum industry's most competent technologists have been focused on this problem of finding new and better ways of gathering and assembling subsurface information during the drilling of wells. They have been eminently successful. With the development of new methods, however, has come the realization that if we would gain the maximum advantage from their use, technologists must be specially trained to apply and interpret the records obtained with them. They require advanced knowledge of scientific principles and an intimate understanding of the influence of many physical and lithologic factors. Complex instrumentation is involved, requiring knowledge of electronics and skill in several engineering fields. The petroleum industry must look to well trained technologists specializing in this work to obtain best results from the new methods. The larger oil companies now employ engineers who are assigned to this special task of assembling the logging records and specially qualified consultants are often employed to assist in their interpretation.

It must not be assumed that this remarkable development has reached its zenith. We should expect further and perhaps even more outstanding new developments. There is still much to be learned in improvement of the present methods, including a better understanding of the factors that influence well-logging records so that they may be interpreted with greater certainty and with more precise quantitative results. Research projects now under way in petroleum industry laboratories are investigating the possibility of applying new techniques based on other approaches than those now employed, involving application of vibration and seismic forces, acoustics, magnetic methods, radiant energy and others. What these researches may ultimately disclose and the new techniques that may follow cannot as yet be visualized clearly. Perhaps we may hope for ultimate development of methods that will indicate with certainty the presence of oil and gas in formation ahead of the drill; methods that will more precisely define the stratigraphic intervals penetrated by wells from which profitable production may be obtained; methods that will indicate the proximity of edge-water lines, oil-water and gas-oil interfaces in petroleum reservoirs. It would be helpful if logging records could indicate, before a well is completed, the initial and ultimate recovery that it will achieve and suggest the distance apart at which other wells in the area should be drilled for most advantageous results. These and other important objectives may be achieved with further improvement of well-logging techniques.

Large sums have been and are currently spent by the more progressive oil companies in well-logging operations and in research looking toward improvement and development of new methods. The results achieved demonstrate that this investment has been profitable, not only in assuring greater current profits in oil industry operations, but also in assembling more complete subsurface information that will be helpful in planning future operations. The more technical and exacting methods of the future petroleum industry will require complete and accurate records of the drilling that is done today. We must look to present-day technologists to assemble as complete a record of their drilling operations as possible to meet the needs of the more scientific industry of tomorrow. Future petroleum technologists will find use for these records, perhaps in ways that are not yet fully visualized.

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Lightweight (30–80 lbs. per cu. ft.). Comparable to insulating brick construction.	*Heavier than insulating concrete (110–120 lbs. per cu. ft.) although somewhat lighter than firebrick construction.*
Low thermal conductivity (somewhat higher than that of insulating brick used).	*Higher thermal conductivity than insulating concrete (although lower than that of firebrick).*
Lower strength than refractory concrete (but higher than insulating brick used).	*Comparatively high strength.*

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RECENT PATENTS

on production and drilling

By Heinz Heinemann and Felix Heinemann

NUMEROUS United States patents have been published recently in the fields of drilling oil and gas wells and of petroleum production from such wells. The present review discusses patents relating to processes in these fields and in an attempt to establish trends of thought, covers the patents issued during approximately the second six months of 1954.

Many types of drilling fluids can be employed during the drilling of bore holes for oil and gas production. It is of considerable importance that the water-in-oil emulsions of these fluids be stable, have suitable viscosity and are not very sensitive to contamination by salt and brine solutions present in the bore hole.

P. W. Fischer and R. A. Rogers (2,687,375 to Union Oil Co. of Calif.) propose a drilling liquid comprising an aqueous suspension of clay, 0.01-10 percent by weight of an alkali metal soap or ammonium soap of carboxylic acid with more than 10 carbon atoms in the molecule or of oil-soluble sulfonic acids, and 0.01-10 percent by weight of a water-soluble hydroxyalkyl cellulose ether in which each of the hydroxyl groups contains at least two carbon atoms. P. L. Menaul (2,689,219 to Stanolind Oil and Gas Co.) describes a stable water-in-oil drilling emulsion which includes 60-80 percent by volume of an aqueous phase, 40-20 percent by volume of oil, and 2-10 pounds per barrel (of the fluid) of an oil-soluble, non-ionic emulsifier consisting of a partial ester of a polyhydric alcohol and a carboxylic acid with at least 12 carbon atoms per mole, such as anhydrosorbitol mono-oleate.

The oil-in-water emulsion drilling mud proposed by R. A. Salathiel (2,697,692 to Standard Oil Dev. Co.) comprises 2-35 percent by weight of an alkali metal soap of a rosin acid with 16-19 carbon atoms, 0.5-3 percent of an aliphatic alcohol with 3- 6 carbon atoms of certain limited chain length, and 95.5-50 percent by weight of an aqueous suspension of finely divided inorganic material such as clay. The product has a low filtration rate and relatively low viscosity.

A rubber-containing drilling fluid is described by H. T. Kennedy and A. J. Teplitz (2,697,071 to Gulf Research and Dev. Co.). In the preparation of this fluid, latex is admixed to heated mineral oil in an amount sufficiently high to lower, by the formation of a protective coating of swelling rubber particles on the wall of the bore hole, the loss of fluid during use. The amount of latex added shall be insufficient, however, to unduly increase the viscosity of the fluid. An amount of 3.5-8.5 pounds latex per barrel of oil is proposed.

For special purposes, such as in electric well-logging operations, it is desirable to make use of an electrically conductive drilling fluid. P. W. Fischer (2,696,468 to Union Oil Co. of Cal.) proposes for this purpose the use of an oil-base drilling fluid which is made conductive by the addition of 5-20 percent by weight of a composition comprising in 100 parts of water 10-40 parts of a mixture of alkali metal hydroxide and a water-soluble salt of a strong base and a weak acid, such as trisodium phosphate. The fluid also contains 20-80 parts of a sulfated or sulfonated emulsifier.

To test whether mud-laden drilling fluids would solidify at high temperatures, K. K. Litman (2,692,895 to National Lead Co.) subjects a sample of the mud to heat treatment in a closed vessel at a temperature of 250-350°F for a period of at least one hour. If the sample is solidified by this treatment, the mud of the system is treated with an amount of an alkaline earth metal alkali corresponding to that which in repeating the test is sufficient to maintain a fluid phase under the test conditions.

In Standard Oil Dev. Company's patent 2,693,856 (T. O. Allen) it is proposed to complete a well traversing a producing formation while the well is maintained under control with a fluid column having a hydrostatic pressure in excess of the pressure of the formation. For this purpose a portion of the drilling fluid in a well casing to be perforated is displaced with a clean liquid weighing 9-18 pounds per gallon which is heavier than the drilling fluid. The casing is then perforated by a tool inserted into the liquid in the casing. The clean liquid prevents plugging of the perforations of the casing.

Plugging of porous formations in a well, on the other hand, is recommended by W. A. Marshall (2,693,857 to The Pure Oil Co.). A permeable siliceous formation penetrated by a bore hole and having a permeability of less than 200 millidarcies is precooled to below the boiling point of water by means of a cooled inert fluid. Hydrofluoric acid is then introduced in an amount sufficient to permeate into and react with the formation. The reaction products formed will further interact with water present to produce gelatinous precipitations which will decrease the permeability of the formation. It is of importance that the formation be maintained cool enough to keep any water formed in the reaction in the liquid state until the precipitates are formed.

A method for cementing wells is proposed by Standard Oil Dev. Co. (T. O. Allen and J. C. McDuffie, Jr.) in 2,689,008. Hydraulic cementitious material is placed in a perforated casing with a high explosive charge arranged within this material. By detonating this charge, at least a portion of the cementitious material is forced through the perforations of the casing, and this material is dehydrated and seals the perforations. C. V. Sidwell (2,695,669) makes use for the cementing of oil and gas wells of a composition which comprises about equal volumes of cement and expanded perlite or volcanic rock and about 5 percent of bentonite (by weight of the cement). When admixed in

(Continued on page 102)

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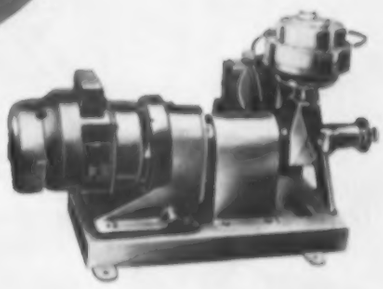
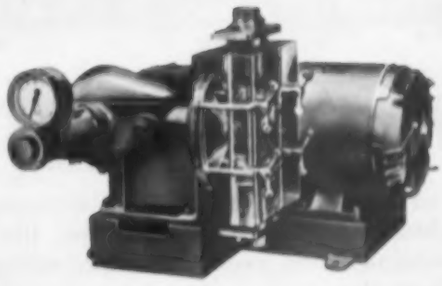
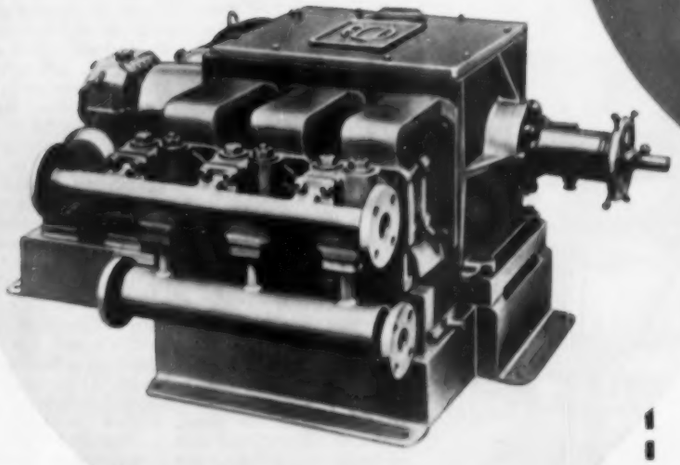




Diaphragm pump micro-capacity control with dial-type stroke adjustment indicator.



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Recent Patents

(Continued from page 100)

proper proportions with water, this composition produces a slurry which is light in weight, can be readily pumped into the well hole and has high compressive strength.

Various methods have been proposed to fracture formations of low permeability for increasing the productivity of a well. E. A. Johnson (2,687,175 to Standard Oil Co. of Ind.) injects a hydrocarbon gel comprising 4-10 percent kerosine and a mixture of aluminum fatty acid soap and acetylene carbon black under hydraulic pressure into a well to fracture a formation traversed by the well. The viscosity of the gel is reduced and the liquid formed is withdrawn from the fracture. According to G. F. Abendroth (2,693,845 to Standard Oil Dev. Co.) a sufficient amount of granular material is introduced into a well to fill it to a point below a casing arranged therein. A fluid suspension of granules is then pumped into the well at a pressure sufficient to fracture the low-permeability formation at a first point and to deposit granular material in the fractured formation. Thereafter, at least a portion of the granular material in the well below the casing is removed to a point below the point of the fractured formation, and a second suspension of granules is pumped into the well at a pressure sufficient to fracture the low-permeability formation at a second point above the remaining granular material and below the first point. The sequence of operations is repeated until a desired number of zones of high permeability is formed.

The acidizing of wells and particularly of siliceous formations has also been described repeatedly. Stanolind Oil and Gas Company's patent 2,689,009 (H. W. Brainerd, Jr., C. R. East, and C. G. Howard) describes the use of an emulsion comprising a strong mineral acid capable of forming water-soluble salts with earth formations and an oily vehicle containing Baltic gum. D. C. Bond and R. H. Lorenz (2,690,428 to The Pure Oil Co.) propose to increase the permeability of calcium-containing siliceous geological formations by treatment with solutions of hydrofluoric acid or fluophosphoric acids with the formation of fluosilicic acid and to add to this treating acid solution from the beginning an amount of fluosilicic acid sufficient to prevent the precipitation of calcium fluoride during the treatment. According to another Pure Oil Co. patent (2,693,855, C. D. Bond) oil producing and water producing siliceous formations traversed by a bore hole are temporarily isolated from each other with a packing device. The oil producing formation is then flushed free from alkali metal salts and alkaline earth metal salts contained in the bore hole. After removal of the packing device, a solution of a fluophosphoric acid is introduced into the bore hole. A portion of this solution is forced into the water producing formation, while the remaining portion is forced into the oil producing formation. Whereas the permeability of the oil producing formation is thus increased, the solution introduced into the water producing formation forms with the metal salts contained therein insoluble precipitates in an amount sufficient to decrease the water producing capacity of this formation.

Methods of preventing accumulation or of removing deposits of solidifying and clogging material, such as paraffinic or asphaltic bodies, in wells have been proposed in various ways. W. S. Crake (2,695,670 to Shell Dev. Co.) proposes to remove deposits of paraffin and similar solidified material from the inner surface of the production tubing of a well by introducing into this tubing from the top to a point at least level with the deposits a metallic flexible line weighted at its lower end. The flexible line is moved in an orbital path relative to the tubing along the inner wall thereof to entirely scrape the deposit from the inner wall of the tubing, while the well fluid is flown upwards through the tubing to remove the scraped-off deposit. J. Kelly (2,698,294) proposes the use of a paraffin solvent consisting of 45-55 percent by weight of turpentine, 25-40 percent of creosote as an emulsifying and weighting agent, and 1-5 percent of sodium hydroxide in 10-15 percent of water.

To prevent the corrosion of ferrous metal parts in wells by their contact with water containing corrosive compounds and associated with petroleum hydrocarbons, e.g., by fluid entering deep wells from continuous earth formations, R. E. Fariss, in patent 2,695,876 (to The Texas Co.), recommends the incorporation into such corroding aqueous solutions of a small amount of zinc chromate in such a manner that the metal surfaces remain in contact with these solutions for an extended period of time. According to A. V. Metler (2,691,631 to Socony-Vacuum Oil Co., Inc.) corrosion is inhibited by the addition to the corroding liquid of 1-500 parts per million (by weight of the liquid) of sodium mercaptobenzothiazole. P. H. Cardwell and C. L. Lunsford (2,698,295 to The Dow Chemical Co.) have proposed for the same purpose to deposit in the well in contact with the metal parts a mixture of 2-80 percent by weight of an alkali metal alkylsulfonamidoacetate of the formula $C_nH_{2n+1}—SO_2NHCO_2M$ where n is 12-18, and 80-2 percent of diethyl urea, diphenyl urea, or the like.

In working oil shale, Socony-Vacuum Oil Co., Inc. in patent 2,688,464 (J. W. Payne) has disclosed a process involving burning a hole in an oil shale which contains 25-65 percent by weight of volatile material and fixed carbon. A portion of the shale surface is heated to 800-1,400°F until ignition is effected. A stream of oxygen-containing gas is thereupon directed to the ignited surface. The rate of flow of this stream is controlled and the gas stream is continuously advanced into the forming oil shale hole. The fused ash produced in the advance of the gas stream is continuously removed.

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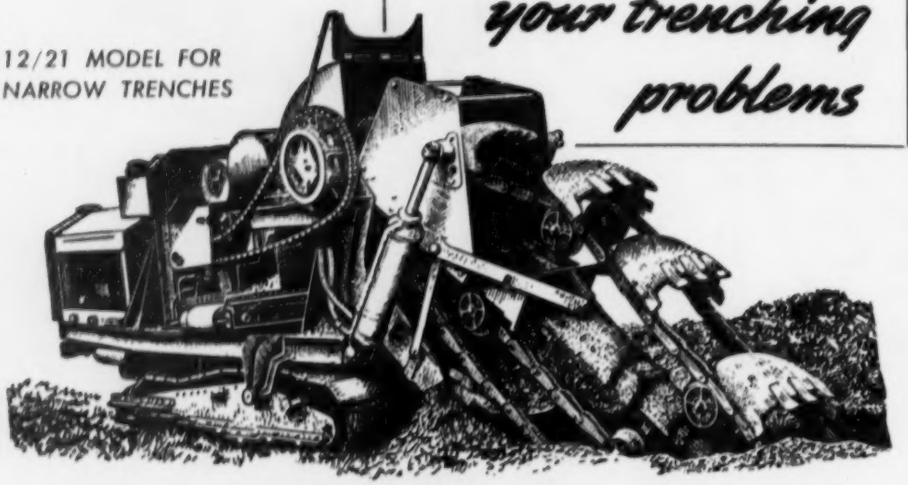

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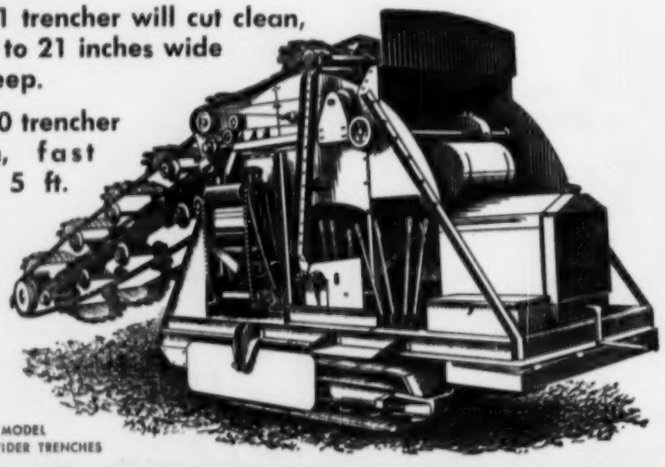

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CANADA

Exploration in British Columbia

George L. McMahon, president of Pacific Petroleums Ltd., has announced that his company, in conjunction with Canadian Atlantic Oil Ltd., Peace River Gas Co. Ltd., and Sunray Oil Co., have joined with Imperial Oil Ltd. to explore the Peace River area of British Columbia. Imperial will earn varying interests in certain oil and gas rights in about two and one half million acres of reservation lands in northeastern British Columbia by an expenditure of $9 million over a three-year period. This money would be used for an exploration program which would include the drilling of five deep wells in addition to other shallower drilling.

Pacific Petroleums and associated companies in agreement will retain ownership of their discovered oil and gas reserves in the area and of any future reserves of gas discovered in the more shallow formations throughout most of the acreage.

Gas Discovery

In mid-January Sunray Oil Corp. made its second gas discovery on a 150,000-acre farmout from Pacific Petroleums, 15 miles north of Fort St. John, B.C. Pacific Sunray Montney No. 3, four miles west of gas discovery No. 2, is reported to have tested the top part of the Gething sand from 3,625 feet at 1,640,000 cubic feet of gas daily in 1½ minutes increasing ot 2,000,000 feet daily in 50 minutes.

Pacific reports that several wildcats in the area have shown small gas indications in the Gething, but this is the first to have hit upon a strong flow from this horizon, thus adding a new gas reservoir to the area.

Define Two New Saskatchewan Fields

South Illerbrun and Instow fields have been defined as producing oil and gas fields by an Order in Council, according to Hon. J. H. Brockelbank, Saskatchewan minister of mineral resources.

Mr. Brockelbank said that regulations set forth under the Oil and Gas Conservation Act will apply to the drilling of and production from oil and gas wells in the fields.

South Illerbrun field is located about 40 miles southwest of Swift Current and 15 miles north and east of Shaunavon. Instow is located about 45 miles southwest of Swift Current and 10 miles north and east of Shaunavon.

Canadian Bishop Has Pembina Show

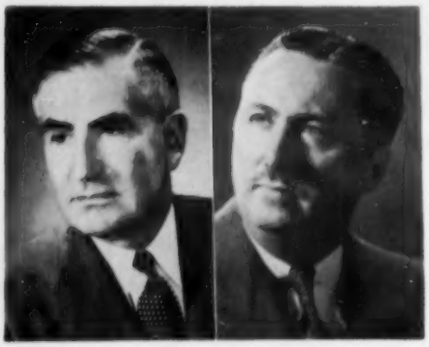
Canadian Bishop Oil Ltd. has announced that its Pembina 8-4 well on a 320-acre Crown Reserve Lease in the Pembina field has been drilled to a total depth of 5,306 feet. A satisfactory drill stem test showing oil and gas has been run, with gas coming to the surface in 12 minutes. The well now is being reamed preparatory to the setting of casing.

New McCullough Branch in Canada

The McCullough Tool Co. has opened a new service location in Drayton Valley, Alberta, according to an announcement by Norman Brookes, manager of the Canadian division. This new location was established by McCullough to serve the requirements of the oil industry in the rapidly expanding Pembina area, southwest of Edmonton.

Appointed by Canadian Petroleum Association

John W. Proctor, of Edmonton, has been appointed executive secretary of the Alberta Division, Canadian Petroleum Association, and will make his headquarters in Calgary. He has been general manager of the Alberta Interfield Gas Lines Ltd. for the past four years. Prior to World War II he had considerable experience in the gold and base metal mining industry, which included management duties and exploration and drilling supervisory assignments. During his military service in World War II, Mr. Proctor was awarded the O.B.E. and M.I.D. and retired from the Canadian Army in September, 1945, with the rank of Acting Brigadier.



C. A. Robinson *D. F. Kindellan*

Imperial Oil Appointments

Imperial Oil announces two senior appointments in the company's marketing divisions. C. A. Robinson has been appointed manager of the Ontario marketing division in Toronto, succeeding the late J. E. Akitt, and D. F. Kindellan, formerly sales manager of the Quebec division, has been named manager of the Manitoba marketing division in Winnipeg.

Royalite Appointments in British Columbia

Royalite Oil Co. Ltd. has announced three new sales staff appointments in British Columbia. W. G. Helmsing, of Vernon, formerly sales representative in Kamloops, has been appointed district representative for the province. Garfield Grant, formerly of Penticton, becomes sales representative in Kamloops, and Errol Dent of Vancouver will be sales representative for Vancouver and the lower mainland.

Ethyl to Build Canadian Plant

Ethyl Corp. has announced plans to build at Sarnia, Ont., a plant to manufacture "Ethyl" antiknock compounds. The plant will be owned and operated by Ethyl Corp. of Canada Ltd., a subsidiary. The new plant will be the first to manufacture antiknock compounds in Canada.

Canadian Crude Prices Cut

Imperial Oil Ltd. reduced its posted prices for crude oil produced in Western Canada by 7 cents per barrel on January 7. The changes apply to Alberta and Saskatchewan crude.

Sun Announces Canadian Appointments

Appointments of Marvin L. Brown and Lloyd E. Miller as assistant division managers for Sun Oil Company's Canadian production division have been announced by division manager George E. Dunlap.

Mr. Brown now has the title of assistant division manager, operating. He will continue to serve as superintendent of the operating department.

Mr. Miller's new title is assistant division manager, exploration. He also continues to serve as division chief geologist.

Albert M. Berlander

Albert M. Berlander, 69, Bechtel Corp. veteran pipe line field official, died of a heart attack November 29 at Port Arthur, Ontario. He was there as a consultant on construction of the Trans-Canada Pipe Lines system.

His service with Bechtel companies began in 1914 during the building of the Northwestern Pacific Railroad from the San Francisco Bay area to Eureka, Calif. Since 1932 he had been active almost continually in pipe line construction and was one of the industry's veterans.

Mr. Berlander had heavy responsibility on the construction of 250 miles of the 718-mile Trans-Mountain Oil Pipe Line in western Canada in 1952-53, and was construction manager over the southern division of the 30-inch Lakehead pipe line extension completed last year under Bechtel management.

Kartzke Chairman of Canadian Petroleum Association

At a meeting of the board of governors of the Canadian Petroleum Association following the annual meeting December 9 in Calgary, Alberta, Paul L. Kartzke, vice president of Shell Oil Co., was elected chairman; Charles Hay, Royalite Hi-Way Ltd., vice chairman; and E. H. Vallat, Triad Oil Co., Ltd., second vice chairman. In addition to Messrs. Kartzke, Hay and Vallat, the following were elected to the board of governors: A. G. Bailey, R. A. Bishop, R. A. Cruickshank, C. U. Daniels, G. E. Dunlap, B. W. Gillispie, H. M. Kirk, G. L. Knox, W. E. C. Mackenzie, H. R. Moorman, and H. W. Stoneman.

P. L. Kartzke

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— From an address by M. J. Rathbone, President, Standard Oil Company (New Jersey)

ESSO

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AND AFFILIATED COMPANIES

BRITISH OIL NEWS

By E. Lawson Lomax

Several men who have gained prominence in connection with petroleum figured in the New Year's Honor list made public in January. Leading the new appointees is Sir William Fraser, who has been made a Baron in recognition of his services to the industry. A slight delay confronted the chairman in selecting his title owing to the fact that so many members of the Fraser clan have inherited or attained titles, including the Fraser name, that it was necessary to find some new and appropriate combination, not a serious difficulty but one involving some thought and serious consideration.

Leonard Sinclair, chairman and managing director of Esso Petroleum Co., was made a Knight Batchelor. Sir Leonard, who was born in Manchester in 1895, joined the Anglo American Oil Co., predecessor of Esso, in 1908. During the first World War he served in the armed forces, rejoining the company on his return and rising through various positions in the marketing division to become assistant general sales manager in 1933. In 1936 he joined the International Association (Petroleum Industry) Ltd. and organization representing the interests of the Esso group.

During World War II he was a director of the Petroleum Board, in 1943 was made a director of Anglo American and in 1949 was made managing director. He became managing director of Esso Petroleum in 1951. A veteran of petroleum service, he has been for many years one of the industry's most honored and respected members.

The order of the Bath (GCB) was conferred on Sir John Primatt Redcliffe Maude, permanent secretary of the Ministry of Fuel and Power.

Robert Crichton, managing director of British Petroleum's Scottish Oils Ltd. prior to his retirement last year after 58 years of service in the oil industry, received the award of CBE.

The MBE award was conferred on Hayden Jestyn Evans, administrative assistant, Shell Mex and BP Ltd., and on Major H. C. McGrath, catering manager at the Kent refinery, the latter award being in the military division.

The British Empire medal was awarded to Edwin James Hadlow, pumpman of the tanker "Laterus" of Shell Tankers Ltd.

Tanker News

It is announced by Shell Tankers Ltd. that the tanker "Auris," in which a gas turbine was fitted to replace one of her four diesel units, is about to be further transformed by having her present power units taken out and replaced by a single 5,500 hp gas turbine. Trials on the first gas turbine have been so satisfactory, it is said, as to justify this further development.

Shell Tankers Ltd. also announce that the STS "Vexilla" of 31,000 dwt was successfully launched at the Birkenhead yard of Cammell Laird & Co. Ltd. on January 11. This is the first of a series of tankers of this size, six of which are being built in British shipyards, four in France and two in Holland.

The "Esso Exeter" of 26,650 dwt was another January launching at the Walker-on-Tyne Naval Yard of Vickers-Armstrong Ltd. This vessel is the last of a series of five similar tankers which have been built for Esso in British yards.

The first of three 33,000 dwt tankers being built for the shipping organization of Société Française des Pétroles B.P., B.P.'s French associate, was launched at Dunkirk on January 11. She was christened "Chambord" by Mme. Delmas, wife of the French Minister of Transport, who performed the launching ceremony.

Personnel

Victor Butler, who has been an under-secretary in the Ministry of Fuel and Power for the past eight years, has resigned and joined the Shell Petroleum Co. Ltd.

B. M. C. Trench has succeeded T. S. Powell as manager of the public relations department of Shell Co. Ltd. following the latter's retirement. Mr. Trench joined Shell as a legal adviser in 1945 following service with the Ministry of Economic Warfare, and served in the legal department until 1952 when he was given a special assignment.

H. W. Barnett, London manager for The Butterley Co., has resigned after 18 years' service. After 30 years spent in engineering, he is starting his own advertising business and intends to specialize in engineering and technical accounts.

Transport Equipment (Thornycroft) Ltd. announce that S. H. Fletcher has been appointed service manager for the commercial vehicle activities of the company. His headquarters will be at Basingstoke.

D. A. Campbell has succeeded A. Angeloni as secretary of the Kuwait Oil Co., and is located in the London office. Mr. Campbell started his career in oil in 1934, when he joined the British Petroleum Co. (then The Anglo-Iranian Oil Co.). A year later he made his first visit to Kuwait, in the very early stages of operations there. From 1942-45 he was chief accountant to the Palestine Consolidated Refineries, but after the war returned to Kuwait where he became assistant general manager. Mr. Angeloni continues as secretary to the Kuwait Oil Co. Trustees Ltd. and as a member of the company's pension fund and investment committee.

New Refinery Installations

A catalytic polymerization plant was recently commissioned at the Antwerp refinery, jointly owned by B.P. Co. and Petrofina. In addition, a catalytic cracker and a distillation unit with a capacity of 900,000 tons per year will be commissioned early in 1955.

At the Lavera refinery of Société Française des Pétroles B.P., a Platformer unit of 250,000 tons yearly capacity was put on stream in January 1955.

B.P.'s first Platformer unit to be commissioned in the United Kingdom came into operation in February and that at Llandarcy is due in April.

A new Platformer unit of 75,000 tons annual capacity is to be built at Porto Marghera refinery in Venice, jointly owned by B.P. and Azienda Generale Italiani Petroli. This brings the number of Platformers ordered by B.P. and its associate companies to seven.

Steel Order Placed

Overseas activity in steel has led to the placing of several orders with British companies. One of these recently announced by Stewarts and Lloyds Ltd. calls for 490 miles of line pipe for the American bases in Spain. The contract is reported to amount to about £2 million and was the subject of stiff international competition.

Esso Reorganizes Sales Staff

Esso Petroleum Co. Ltd. has announced a reorganization of its general sales department effective January 1. A new division is established within the department to be known as the national trade division and to include an aviation department and a national accounts department. Instead of three assistant general sales managers, there will be two regional managers and a costs and operations manager.

Consequent upon this reorganization the following appointments have been announced: A. W. Wooldridge, who has been assistant general sales manager, is to be regional manager (south). He joined the company in 1923, and after serving in branch offices, he became manager of the lubricating oils department in 1929. In 1939 he was appointed manager of the northern division. He was with the Petroleum Board during the war and then returned to his former position until his appointment as assistant general sales manager at the London main office in February 1952.

E. F. Choppen, former assistant general sales manager, is made costs and operations manager. He joined the company in 1930 as a chemist in the technical sales department, where he remained until 1939. After service with the Petroleum Board, he held positions as sales manager and divisional manager of the company's northern division. He moved to the London office as assistant general sales manager in 1953.

E. W. Hardiman, manager of the southwestern division, becomes regional manager (north) in succession to R. A. Hyslop, who has retired after 44 years' service with the company. Mr. Hardiman joined the company in 1931 and in 1937 became assistant to Dr. Garner, now Professor of Chemical Engineering at Birmingham University, at Esso's European laboratories. After war service with the R.A.S.C. (Major) and various special assignments, he returned to the company and held successively the posts of motor oils manager, motor fuels manager, divisional sales manager (northern division), manager advertising and sales promotion, and manager of the southwestern division prior to his present appointment.

R. D. Streeton, manager of the wholesale department, becomes manager of the southwestern division, replacing Mr. Hardiman. T. C. G. Thorpe, deputy manager, becomes manager, wholesale department, in succession to Mr. Streeton. H. W. Wright, deputy manager, becomes manager of the marketing secretariat in succession to T. Bourhill, who has retired after 43 years' service. H. A. D. Airey, divisional sales manager of the northern division, becomes manager of the newly-constituted national trade division.

New appointments include D. D. Campbell, who succeeds Mr. Airey as division sales manager; J. Sutherland, who becomes cost and operations manager, northern division; and M. L. McLaughlin, who succeeds Mr. Sutherland as district manager.

R. G. Protheroe becomes manager of Purfleet Terminal in place of P. Low, who is retiring after 35 years' service with the company. Mr. Protheroe joined the company in 1938 as an engineer draughtsman, transferring to Purfleet five years later.

A. W. Wooldridge

E. F. Choppen

E. W. Hardiman

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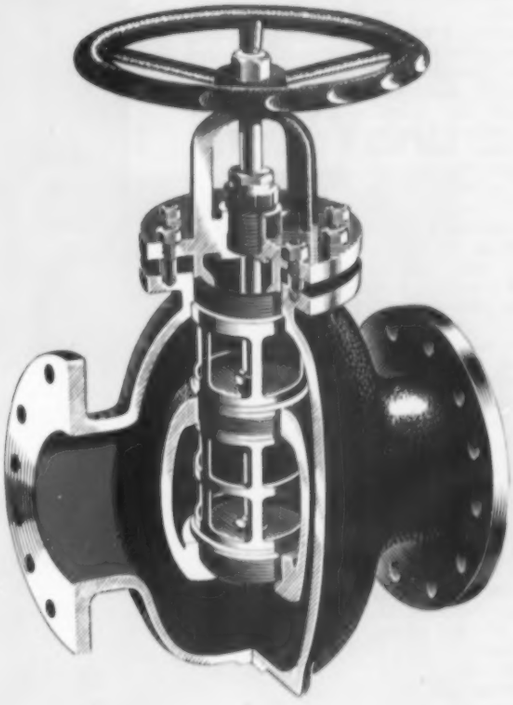

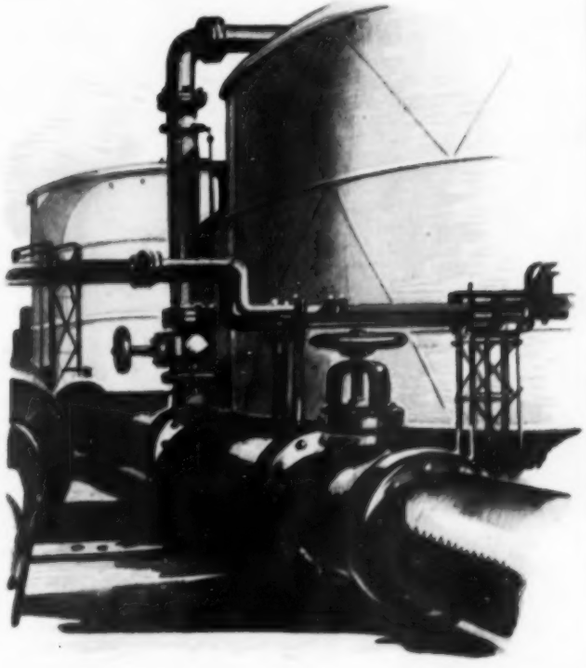

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OIL COMPANY STAFF CHANGES

V. C. GEORGESCU has been appointed an assistant coordinator of the producing activities of Standard Oil Co. (N.J.) and Henry E. Winter has become regional executive for South American producing.

Mr. Georgescu, a naturalized American citizen, was long associated with the oil industry in his native Romania, serving with a Jersey Standard affiliate there before joining the parent organization at New York in 1947. Since then he has been assigned to the company's production coordination staff, dealing primarily with Middle East and Far East operations.

Following oil field and petroleum equipment sales work in Romania, Mr. Georgescu joined Romano-Americana, a Jersey Standard affiliate headquartered at Bucharest, in 1937. Two years later he was appointed its managing director and in 1944 was elected president and chairman. Romano-Americana was nationalized by Romania's communist government in 1948.

Mr. Winter joined Lago Oil & Transport Co. Ltd. in Aruba, N.W.I., as a student engineer in 1934. From 1939 to 1954 he served with Jersey Standard affiliates in Venezuela, becoming manager of Creole Petroleum Corporation's economics department in Caracas in 1948 and later manager of its western division at Maracaibo in 1953. He joined the Jersey Standard producing coordination staff last August.

V. C. Georgescu

KENNETH H. WHITE, Ponca City, staff assistant in Continental Oil Company's transportation department, has been promoted to traffic manager for Egyptian-American Oil Co., a subsidiary of Continental. He will continue to make his headquarters at Ponca City.

Egyptian-American Oil Co. is exploring for oil in a 75,000-square mile area in Egypt. In his new position, Mr. White will coordinate the movement of personnel, materials and equipment to the company's operations in Egypt.

S. P. OSBORN has been elected assistant comptroller of Texas Eastern Transmission Corp. Mr. Osborn joined Texas Eastern in January 1948, and has served the company as chief accountant from that time until the present. Prior to coming with Texas Eastern, Mr. Osborn was assistant treasurer for Columbia Gas System Companies.

S. P. Osborn

R. S. RITCHIE has succeeded A. A. Turner as manager of the British Columbia marketing division of Imperial Oil Ltd. Mr. Turner, marketing manager since July 1952, has moved to Imperial's Toronto headquarters office as coordinator of the company's marketing training.

A 1938 graduate of the University of Western Ontario in political economy, Mr. Ritchie did post-graduate work in economics at Queen's University. After joining Imperial in 1947, he spent several months studying methods of Standard Oil (New Jersey) in their New York offices. He is the author of an essay, "Western Oil: Its Economic Implications."

JOHN J. ARPS has been appointed vice president in charge of the economics and evaluation department of The British-American Oil Producing Co. Mr. Arps, a native of The Netherlands, after various assignments with another oil company in Eastern Europe, the Far East, South America, and the United States, joined British-American as district engineer for their Gulf Coast area in 1940. He has since held positions of district superintendent, chief engineer, acting production manager, and assistant to the executive vice president.

J. J. Arps

GEORGE B. PARKS, formerly manager of the production department of Kerr-McGee Oil Industries, Inc., has been appointed general manager of the production department and drilling operations, a new position. William F. Baxter, formerly drilling superintendent, was named manager of drilling operations, Gulf coast division, a new title. His office will be in Kermac's Morgan City, La. branch.

G. Otis Danielson, formerly assistant manager of the drilling department and chief drilling engineer, became manager of drilling operations for Kermac's mid-continent and Rocky Mountain divisions, another newly established position.

Charles F. Miller, general superintendent of the production department, was moved up to manager, production department, to fill the vacancy left by Mr. Park's promotion. Burrell Taylor was named general superintendent, production department, to fill Mr. Miller's former job. He had been chief production engineer.

JASON COOPER, JR., formerly assistant manager of employee relations, has been named coordinator of management development of Esso Standard Oil Co. He succeeds J. N. Gorringe, who has been made employee relations manager.

In his new position, Mr. Cooper will be responsible for coordinating a company-wide program of selection and development of individuals to provide a reserve of executive talent to meet the future needs of the company.

Mr. Cooper joined the company in 1927 in the New Jersey division, where he subsequently served successively as personnel manager, merchandising assistant and manager of the Hackensack district. After service with the United States Navy, he returned to the New Jersey division in 1946 as personnel and public relations manager. He transferred to the New York offices the following year and was made assistant employee relations manager in 1950.

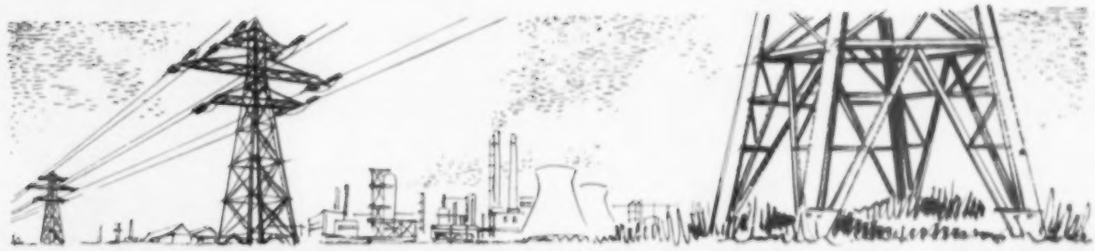
E. J. WACKER has been named vice president of Magnolia Pipe Line Co. He will have charge of the company's engineering, communications and electrical departments. Mr. Wacker joined Magnolia as a mechanical engineer in March 1939. Eight years later he was made assistant chief mechanical engineer. During the last two years he has been working with Socony-Vacuum Oil Co., Inc., in New York.

D. R. Wall has been appointed manager of crude oil purchases for Magnolia Petroleum Co. He joined the company as an office boy in 1941 and has held many post of increasing importance in recent years. In 1952, he was appointed assistant manager of the crude purchases and sales department.

E. J. SCHIFFER, general traffic manager of Gulf Oil Corp., retired January 1. He was succeeded by W. M. Johnson.

A veteran of 39 years of service, Mr. Schiffer joined Gulf in 1915. He was named assistant general traffic manager in 1945 and two years later was appointed general traffic manager. Mr. Johnson joined Gulf in 1927 as a messenger and in 1950 he was promoted to assistant general traffic manager.

JOHN D. KING of Chicago has been elected a vice president and director of Cities Service Oil Co. (Del.) and appointed manager of the company's marketing division. He succeeds Edward L. Stauffacher of Chicago, who has been elected to the presidency of Cities Service Oil Co. (Pa.). Mr. King has served the division as counsel for the past 11 years.



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CHRISTOPHER STORY, vice president of Cities Service Oil Co. (Pa.) in charge of marine operations, has resigned for reasons of ill health after more than 40 years in the shipping business.

Mr. Story has been associated with Cities Service since 1919, and during most of that period was in charge of the Cities Service tanker fleet, which he expanded and rebuilt into one of the most modern tanker fleets in the country. Although discontinuing active duties, Mr. Story will serve as consultant on the construction of three new tankers and on other phases of tanker operation.

J. M. BRACKENBURY, formerly assistant manager of the Shell Oil Co. Montreal refinery, has been appointed superintendent of Martinez refinery in California. Mr. Brackenbury joined Shell in 1933 at Wilmington refinery in the United States.

JOHN R. YODER of Cody, Wyoming, production superintendent of the Israel-American Oil Corp., is supervising an experienced American crew now drilling Israel-American's first deep test well in Israel. The company spudded in the well 25 miles south of historic Beersheba on December 3 on its Boqer license, one of the company's seven covering more than 500,000 acres in Israel. This is the fifth exploratory well now underway in Israel, and is projected to go down to between 7,500 and 8,500 feet to explore the unknown sections below the Triassic beds there.

Mr. Yoder, who has been associated with oil drilling and production operations for over 25 years and has supervised the drilling of more than 40 development and wildcat wells in the Southwest, was production superintendent of Husky Oil Co. of Cody, Wyoming for four years prior to his joining Israel-American.

J. R. Yoder

JOHN M. BALLACHEY has been appointed executive assistant to the general manager of the Alberta Gas Trunk Line Co. Ltd., it was announced by Ralph Will, president. Since July 1951 Mr. Ballachey has been assistant to the president of the Canadian Petroleum Association.

RICHARD E. HOWE has been appointed general manager of Standard-Vacuum Oil Company's marine department and coordinator for the company's international tanker fleet of some 50 deepsea vessels operating in the eastern hemisphere. He succeeds John M. B. Howard, who resigned to join Esso Shipping Co.

Stanvac also announced the appointment of A. J. Vecsey as executive assistant general manager of its marine department and assistant marine transportation coordinator, and J. N. Stevens as assistant general manager of the department.

Mr. Howe started in the oil industry 21 years ago in the marine department of Standard Oil Co. (N.J.) He was loaned to the government for important tanker supply work during the early part of World War II, and later served as an officer in the U. S. Navy for more than three years. Following the war he spent four years in London with Esso Transportation Co. before his appointment as assistant general manager of Stanvac's marine department in January 1950.

Mr. Vecsey has been traffic manager for Stanvac since 1946. Beginning his oil career as a junior clerk in 1928, he later became chief of foreign marine transportation operations for Stanvac.

Mr. Stevens, a naval architect and licensed chief engineer, whose background includes engineering research and ship designing, entered the oil transportation field 13 years ago. He joined Stanvac in 1946, served as a marine superintendent in the Persian Gulf area and was named operations manager at the company's headquarters office two years ago.

R. E. Howe

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CANADA	MONTREAL	ITALY	TRIESTE	SWEDEN	GOTHENBURG
CANADA	VANCOUVER	JAPAN	KOBE	U.S.A.	NEW YORK
DENMARK	COPENHAGEN	MEXICO	MEXICO CITY	U.S.A.	SAN FRANCISCO
FRANCE	LE HAVRE	NORWAY	BERGEN	VENEZUELA	MARACAIBO

Cia Mexicana de Pinturas "International" S.A., Apartado 1337, Mexico City.

G. A. LORENZ has been appointed assistant manager of Shell Oil Co. of Canada. He was formerly assistant superintendent at Wilmington refinery in the United States. Mr. Lorenz comes to Montreal after many years of experience with associated companies in the United States and The Netherlands.

E. A. MARKLEY, manager of the geological department of Sunray Oil Corp., retired February 1 after 31 years with Sunray and predecessor companies. He entered oil work in 1922 with the old Kawfield Oil Co., which operated at Tulsa and Cushing. From 1924 to 1926 he was associated with the former Waite Phillips company which was merged into the former Barnsdall Oil Co. in 1926. He served as chief geologist for Barnsdall from 1932 until 1950, at which time the Barnsdall company was merged into Sunray and Mr. Markley became a manager of the geological department.

CHARLES S. MITCHELL has been appointed manager of all transportation facilities of Cities Service, with headquarters in New York. Mr. Mitchell has been with Cities Service for the last 25 years in various capacities, and since 1950 has been manager of the crude oil supply and transportation division of the Cities Service Oil Co. (Del.), with headquarters in Bartlesville, Okla. He is also president of Cities Service Pipe Line Co. and an officer and director of several other subsidiary and affiliated companies of the Cities Service system.

GEORGE C. CAINE has been relieved of his duties as general superintendent of Tide Water Associated Oil Company's Bayonne, N.J., refinery, to direct and co-ordinate all activities relating to the planning, design and development of the company's new refinery scheduled to be built somewhere along the eastern seaboard.

C. S. Mitchell

JACK R. BRUNER, formerly chemical engineer with George Armistead and Co., has joined the refining staff of Hancock Oil Co. Mr. Bruner previously worked for New Mexico Asphalt and Refining Co. and Southwestern Engineering Co. and served as project manager for the Armistead organization during the recent extensive construction project at Hancock Oil Co.

R. L. SANDERS, Ponca City, has been promoted to superintendent of Continental Pipe Line Company's Louisiana district, with headquarters at Lake Charles, La. Formerly chief clerk for Continental Pipe Line Co., a subsidiary of Continental Oil Co., he replaces Frank Beard, who was recently transferred to Madison, Wis., as superintendent of the Madison and Amboy, Ill., petroleum terminals.

JOHN O. CAMPBELL, JR., assistant head of the crude oil and gas sales department of the Carter Oil Co., has been named head of the department. He replaces Dan W. Cameron, resigned. Joe C. Kahl, secretary of the executive committee, became assistant to the manager.

THOMAS P. SIMPSON has been elected vice president and director of manufacturing of General Petroleum Corp. Mr. Simpson joined the company as a chemical engineer in 1924. In 1935 he was transferred to the Socony-Vacuum Oil Co., Inc., as chief development engineer of the Socony-Vacuum Laboratories. He became director, research and development department, of Socony-Vacuum in 1947, with headquarters in Paulsboro, N.J.

Upon his return to General Petroleum in August 1953, he became assistant director of manufacturing, from which post he has now been promoted.

T. P. Simpson

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Special control circuits allow rapid field selection of AGC characteristics, mixing method and percentage, and type of record presentation. Hundreds of filter combinations are provided. Matching procedures are simpler than ever before . . . only moments are required to change recording characteristics.

The G-22 System is designed for high-production operation under all conditions from high noise level, multiple shothole areas to "shoot and move" recording. Regardless of the application, with magnetic or photographic recording media, the G-22 provides the ultimate in operating flexibility.

AGC Control Range: One-half microvolt to one volt input.

Low Distortion: Less than 1% from 10 to 300 cycles-per-second at 0.1 volt input.

Multi-control AGC: Independent selection of attack and release time-constants for maximum event resolution. Nine AGC time-combinations each channel.

Gain Control Circuits: AGC, Expander, or simultaneous AGC-Expander operation.

Frequency Response: Within 3 db from 5 to 300 cps. Filtering as specified.

- First-Arrivals Unfiltered.
- Individual Channel Paralleling and Testing Switches.
- Anodized Aluminum Construction.
- For use with MR-4 Magnetic Recording System or RO-22 Photographic Oscillographs.

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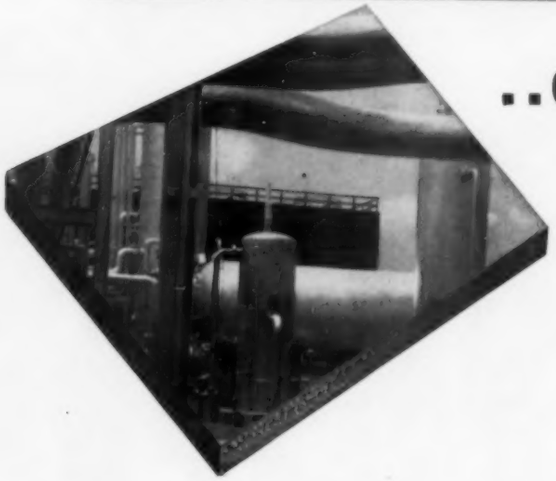

..only part of the picture

OIL REFINERY ENGINEERS know that Newalls bring more than materials to the site, because they realise that even first class insulation materials cannot do justice to themselves unless they are efficiently applied. In fact, the task of planning that the right materials are used is a job studied carefully by Newalls before their recommendations are submitted. Through consultation with Newalls you can make very certain that method as well as materials is brought to bear on the problem. That's maybe why Newalls record of refinery insulation jobs makes such an impressive picture.

RECENT CONTRACTS **Among the large petroleum projects to which Newalls have supplied insulation materials recently are the Anglo Iranian Oil Company's new refineries at Aden and Kwinana and also the new Brazilian State Refinery at Cubatao, Brazil.**

Where there's a HEAT INSULATION problem there's a job for **Newalls**

NEWALLS INSULATION CO. LTD. *Head Office:* Washington, Co. Durham, England. *A member of the* TURNER & NEWALL ORGANISATION
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BIRMINGHAM, BELFAST, BRISTOL & CARDIFF *Agents and Vendors in most markets abroad*

INTERNATIONAL NEWS AND NOTES

Progress in Iran

The pattern of Consortium operations since the ratification of the Iranian agreement is gradually developing, but progress is essentially slow in large operations of this kind. The membership of the directorates of the operating companies has not yet been published and some part of the delay in this matter probably has its origin in the difficulty of deciding upon the Iranian members of the board. Iran is naturally cautious about these appointments, which are of great present and future importance to the country's financial standing and economy. It is understood, however, that the nominations are unlikely to be held off much longer.

In the meantime, production of crude oil from the fields is approaching the target figures of 17,500,000 cubic meters, or about 15 million tons for the first year, and there seems to be little doubt that under the guidance and advice of the technicians in charge this figure for 1955 will be achieved, the production figures for November and December being 1,400,000 tons.

Crude oil production for the first 10 months of 1954 was officially given by NIOC as 3,294,839 tons, but whether this was the gross figure (before allowing for re-circulation) or the net was not stated. Iran's internal consumption during 1954 was a maximum of 1.5 million tons of refined products, while in addition certain exports of crude were made to Italy and Japan, but these would not total up to the official figure and so it is probable that this figure was gross and did not allow for re-circulation.

More units of the Abadan refinery are being put on stream under the auspices of the technical staff and the amount of crude oil charged to the plants for refining should show a steady increase. At present, details of these operations are not available, except that during November and December 900,000 tons of oil was processed at Abadan.

The National Iranian Oil Co. is continuing deliveries of crude oil to Italy and Japan, and it appears to be its intention to continue disposing of its 12.5 percent of production in this manner, rather than by selling it to the Consortium companies. Negotiations are in progress with Supor in Italy and Ide-Mitsu in Japan regarding new agreements for this oil, but under present conditions, NIOC is in a position to obtain better prices than it has said to have received in the past, and so these agreements may be delayed by bargaining.

Out of the sales of oil in the past to Italy, Iran is to be supplied with the equipment for two spinning mills to be erected at Karadj and Kazrin.

From the revenue arising from the Consortium's operations, Iran, among other projects, has decided to develop electric power in different parts of the country and has called for tenders for the supply of equipment from various countries.

For the smaller units, where not more than 1,000 kw will be required, diesel engines will be employed, and for the larger units steam turbines will be used. It is proposed to add 50,000 kw to the existing power supply of Teheran.

Another plan of the government is the laying of some 6,000 kilometers of asphalted roads. This work is to be carried out by Iranian contractors under the supervision of John Mowlem Ltd., London, who will supply the necessary tools and equipment on credit and will receive a fee of six percent of cost for their services.

Another scheme under consideration is the reopening of the Abadan Technical School as a government school for the study of petroleum which will probably be staffed by some of the teachers from the original school and from the higher Technical School at Teheran. A proposal is on foot also for the building of further cement works in order to increase the cement production in Iran.

At the present time there are two nationally owned oil companies operating in Iran; the National Iranian Oil Co. (NIOC) and the Iranian Oil Co. (IOC) and a proposal has been made for their amalgamation.

The latter company, which is more than five years old, is engaged in operations at Alborz, near Qum, where three wells have been drilled and a fourth is in course of drilling.

Venezuela Still Studying Concessions

No decision has been reached regarding the granting of additional oil concessions in Venezuela, Dr. Edmundo Luongo Cabello, Minister of Mines, stated on January 15 in an interview with foreign news writers attending the inauguration of Creole Petroleum Corporation's Tia Juana No. 1 repressuring plant. Rumors have been current from time to time in recent years that the government was about to take definite action. Several independent companies are known to have filed applications and have had representatives on the ground or have opened offices.

Dr. Luongo stated that the administration has been continuously studying the matter with a view to promoting the best interests of the Venezuelan nation. His thought is that it will be advantageous to make sure that there is enough oil in sight to meet current market demands without waste, and enough reserves to ensure availability of supply over both the near term and the more distant future. Venezuela now has a known reserve of about ten billion barrels and is producing at the rate of nearly 700 million barrels yearly.

Floods in Kuwait

The exceptionally heavy and protracted rainfall in Kuwait late in November resulted in very little damage to the Kuwait Oil Company's installations, but widespread flooding resulted in some loss of life, destruction of homes and interruption of communications. Company personnel and equipment were pressed into service, providing fire pumps and water tankers to clear flooded areas, transport to assist relief operations, tents and sandbags, and meals for the homeless.

Rogers to Explore in France

Rogers Geophysical Co. has been engaged by Societe Nationale des Petroles d'Aquitaine to do extensive work in the Bordeaux Basin in France.

The Rogers crew will be stationed in Pau, with Guy Ratcliff supervising the work in the Bordeaux Basin. Rogers European headquarters are located at 8 Rue de Richelieu in Paris with Roger Henquet in charge.

Stanvac to Explore British Somaliland

Exploration rights in British Somaliland, covering 11,380 square miles, have been acquired by Standard-Vacuum Oil Co. through an assignment of rights held in that country by Moriqui Exploration Co.

Standard-Vacuum has announced that it will continue and expand the geological activity started by the Moriqui firm. Geologists at the present time are undertaking an extensive surface study in the area to check the findings of a recent aerial survey.

Creole to List on Caracas Exchange

The board of directors of Creole Petroleum Corp. has authorized the management to arrange for the listing of the company's capital stock on the Caracas stock exchange.

Trading in the company's shares will not take place on the Caracas stock exchange until after its application for listing is submitted and accepted and the necessary legal requirements have been completed.

Aerial view of the Caribbean Refining Company's new $11,000,000 plant nearing completion in a newly developing industrial center across the harbor from San Juan, Puerto Rico. To be completed and in operation this spring, it will initially refine 10,000 barrels of crude oil daily. In the background may be seen some of the new industrial plants recently constructed. A second oil refinery is being built on Puerto Rico's south coast with a 22,000-barrel daily capacity.

OIL
MUST BE DISCOVERED

Some of the rough hills encountered by SSL in Western Australia. A recording unit can be seen in the foreground.

AUSTRALIA was the last of the continents to become an oil producer. It presents many difficulties of a geological nature to those who would explore for oil. Parts of the country are hard on men and equipment: seismic surveys especially, meet technical problems which fully extend the resources of a crew. In addition, they may have to contend with the great hazards of cyclones and bush fires, and minor irritants such as the cruel sting of the Spinifex and the special taste of the Emus for electrical cable.

Prospecting for oil in Australia is only one of the many assignments contracted for by Seismograph Service Limited. Since SSL is able to draw on world-wide experience accumulated by itself and its associated companies – Seismograph Service Corporation U.S.A., Seismograph Service Corporation of Venezuela, America and Canada, and Compagnie Francaise de Prospection Sismique of France – SSL is best prepared to meet new problems and work in strange terrains.

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SUBSIDIARY OF SEISMOGRAPH SERVICE CORPORATION, TULSA, OKLAHOMA, U. S. A.

Aramco Sponsors Trachoma Research

The Arabian American Co. has announced the undertaking of a five-year $500,000 research program with the Harvard School of Public Health in an effort to discover a vaccine for the prevention of trachoma. The program will constitute the first large-scale attempt to attack this serious world-wide eye disease from the standpoint of prevention. Previous efforts have been directed primarily toward a cure.

Aramco will contribute funds at the rate of $100,000 annually. The company also will make available the facilities of its new medical center in Dhahran, Saudi Arabia, through Dr. Robert Page, Aramco's medical director. A large part of a second floor wing of the Dhahran clinic, including three ultra-modern laboratories, has been reserved for the project.

New Housing Plan

Creole Petroleum Corp. has adopted a new experimental housing plan in connection with its refinery at Amuay, Venezuela. Under the new plan employees will be assisted in buying their own homes instead of occupying company housing on a rental basis. The company believes that home ownership on the part of employees contributes to improved morale and responsibility.

To make the project attractive, Creole offers to loan $6,600 without a down payment and to permit the worker to occupy the home without amortization or rental payments. At the end of 15 years the home belongs to the worker. Larger loans up to $13,200 are made, but the worker in this case makes monthly contributions. On the largest sum, payments will be a little less than $20 per month.

Stanvac Expands in Indonesia

A capital investment program that is expected to reach between 70 and 80 million dollars over the next four years has been initiated in Indonesia by Standard-Vacuum Oil Co.

Announcement of the program, which will result in substantial benefits to the Indonesian economy, was made in Djakarta by G. L. McCoy, head of Stanvac's operating units in that country. The American-owned oil company regularly employs some 13,000 people, more than 95 percent of whom are Indonesian nationals.

High on the list of projects which Stanvac will carry out is the construction of a 90-mile pipe line across difficult terrain to tap the new Lirik oil field in Central Sumatra. With completion of this transportation link in 1957 or 1958, crude from the Lirik field will become commercially available for the first time.

Other substantial parts of Stanvac's proposed capital outlay are earmarked for further development drilling of the field itself, as well as for an extensive modernization program at the company's Sungei Gerong refinery near Palembang in South Sumatra.

Extensions to Woodstock Research Center

Extensions costing £150,000 are being made to the facilities at Woodstock Farm, near Sittingbourne, Kent, Shell's agricultural research center in Britain. When completed in April, the enlarged research station will undertake all the agricultural research previously carried out at Shell laboratories in other parts of the country and in Holland. Woodstock will not only test, but synthesize and analyze many complex new chemicals. The staff will be increased to nearly 100.

The new buildings will consist of three laboratories, an administration block, an engineering workshop and two greenhouses. Laboratory space will be increased more than fivefold from the present 4,000 square feet to 21,000 square feet, with separate departments for special research in insecticides, fungicides and herbicides.

Dow Enters the Netherlands

The Dow Chemical Co. will establish a wholly-owned subsidiary company to be known as Nederlandsche Dow Maatschappij N.V., in Rotterdam, Dr. Leland I. Doan, president, announces. The new company plans to build a manufacturing plant as well as tank storage, warehouse and dock facilities on a 50-acre tract leased for 20 years. Among the products the firm plans to process are styron, magnesium, alloys, glycols, including the Dowanols, and certain other chemicals now undergoing economic study. Polystyrene production will include processing of styron in a variety of colors for molded application. Some petrochemical raw materials will be imported in tankers.

Epoxide Resins Patent Agreement

An agreement has been reached between Aero Research Ltd. and Shell Chemicals Ltd. covering, in the United Kingdom, the patents held by Ciba and Shell in the field of epoxide resins.

The agreement will be of particular value to the paint industry in that it will give freedom under both the Ciba and Shell patents to all purchasers of epoxide resins from either company to sell or use these materials in the surface coating field.

Bolivia to Barter Gasoline for Chilean Steel

The YPFB (Bolivian Oil Administration) and the Corporacion Chilena de Fomento signed an agreement on October 20 for the barter exchange of 1,200,000 liters of Bolivian gasoline per month for Chilean steel products. The yearly value of this gasoline is put at U.S. $500,000. Delivery was to start through the port of Antofagasta by tank cars, beginning January 1, 1955.

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Harbormasters are complete marine power and steering units . . . *in one package . . . easily installed for immediate use* . . . combining outboard maneuverability with heavy-duty performance. Shown here are just some of the uses where their great maneuverability and heavy-duty performance are paying off.

If you need easily installed power, better steering control, safety in shallow water, easier maintenance, more efficient performance, simpler hull design, more cargo space, bigger payloads, or simplified crew operation . . . you should investigate the benefits of Harbormaster Outboard Propulsion and Steering.

In the new Harbormaster Catalog you'll find detailed information and also many interesting Harbormaster installation photos. Send for your copy today.

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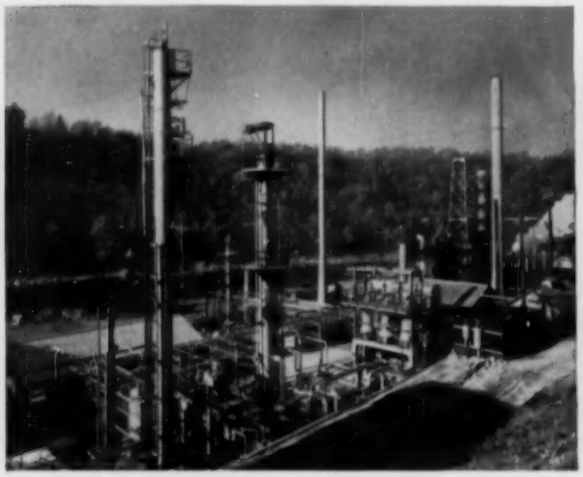
Standing out in bold relief are the reactor-heater section (left) and compressor house of the 1,500 barrel per day UOP Platforming unit — the largest of three built for Quaker State Oil Refining Corporation — at the company's Farmer's Valley, Pa., refinery.



The Allegheny River is only a stone's throw from the Platforming unit at Quaker State's refinery at Emlenton, Pa. The unit has a daily capacity of 1,000 B/SD.

Rolling hills loom behind the 1,000 barrel per day Platformer at the St. Marys (W. Va.) refinery of Quaker State. The unit is a duplicate of the one at Emlenton.

Three UOP Platforming Units Solve Pressing Octane Problem For Quaker State Oil Refining Corp.

By Guy B. Hunter
Executive Vice President
Quaker State Oil Refining Corporation
Oil City, Pennsylvania

OUR company recently concluded a three-way program of product improvement which was highlighted by the installation of three UOP Platforming units, thus giving Quaker State Oil Refining Corporation the distinction of being the first independent refiner to build three of these units at one time.

Guy B. Hunter

Quaker State for more than half a century has been world renowned for its lubricating oils. Its gasolines, distributed under the brand name of "Sterling," have enjoyed an equally high reputation in the marketing areas of our three refineries at Farmer's Valley and Emlenton, Pa., and St. Marys, W. Va. The English pound sterling sign, symbol of our gasolines, always has been the motorist's assurance that he was purchasing the highest quality motor fuels that the petroleum refining industry was able to produce.

We experienced little or no difficulty in meeting octane requirements as the trend moved upward toward more powerful gasolines, but as the level approached 93 we were confronted with a serious problem because our thermal cracking equipment could not be operated economically above that figure. It was therefore apparent that if "Sterling" gasolines were to continue their leading position, another way must be found to increase our octanes.

Planned for the Future

We not only had the immediate problem of producing a higher quality motor fuel but we, like so many other independent refiners, also had to "take out insurance" against the day when octane levels would be still higher. A thorough study of the catalytic reforming field convinced us that the UOP Platforming process was indeed the answer to the situation and would give us an ample octane potential cushion for the future.

We based our decision to install Platforming at all of our refineries on four major factors which were, briefly, the commercially proved experience of Platforming; the proved reliability and the many years of satisfactory service we received from Universal Oil Products Company; the high degree of market flexibility which the process would give to our operations, and the conviction that we would be equipped to meet all anticipated octane increases in the foreseeable future.

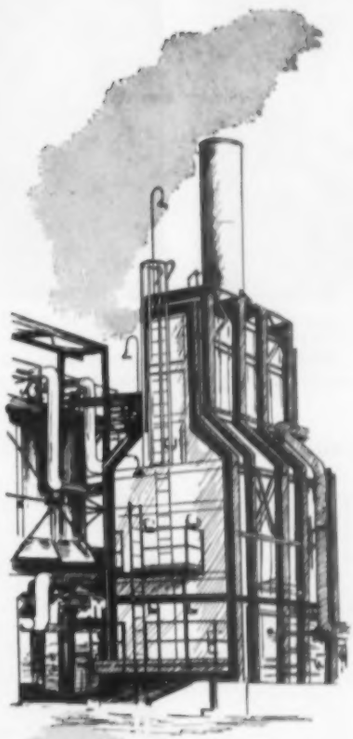
Operation of the three Platformers has convinced us that our selection was a wise one. "Sterling" gasolines now are among the highest octane motor fuels available in our marketing areas, which are concentrated through the heart of the Allegheny Mountains in Western Pennsylvania and along the upper reaches of the Ohio River in West Virginia. Additionally, through Platforming, we have been able to increase substantially our overall cracking capacity by utilizing existing thermal reforming equipment for more extensive cracking service.

Full Boiling Range Gasoline

Quaker State is among the first to produce a 98 leaded octane Platformate. Furthermore, when the unit at Farmer's Valley went on stream, it marked the first time that a Platformer in the Eastern part of the United States was operating on full boiling range gasoline.

The same type of charge stock is fed to the Platforming units at Emlenton and at St. Marys. It boils in the range of 80° F. to 400° F., and it is low in naphthene content. Despite the fact that the feed stock contains an unusually high contaminant concentration, special provisions in the design of the units have enabled us to maintain satisfactory operations at the desired octane number.

We are more than satisfied with the operation of our three Platforming units, which give us a daily capacity of high quality gasoline as follows: 1,500 B/SD at Farmer's Valley and 1,000 B/SD each at Emlenton and St. Marys. From the standpoint of economics, we are pleased to report that Platforming has made it possible for Quaker State to produce 98 leaded octane gasoline at a yield of 81.8 per cent as against our previous operations by which we produced a 93 leaded octane product at 72 per cent yield.



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Universal Service
Protects Your Investment

Dr. Edmundo Luongo Cabello, Venezuela minister of mines, left, and H. W. Haight, president of Creole Petroleum Corp., right, speaking at the inauguration of Tia Juana No. 1. Dr. Luongo hailed the technical revolution of recent years which has developed such conservation plants to increase ultimate recoveries and particularly praised Creole for its large investment in conservation.

Keel Laid for New Sinclair Tanker

Keel for the first U. S. ocean-going merchant ship to be ordered from an American shipyard in two years was laid at Baltimore November 4 to begin construction of Sinclair Refining Company's new 25,000-dwt tankship on the ways of Bethlehem Sparrows Point Shipyard, Inc.

Opens Montana Branch

McCullough Tool Co. has opened a branch service location at Cut Bank, Mont. The new branch is fully equipped to serve the Cut Bank area with all wire line and fishing tool services. Dallas Novak has been appointed branch manager.

Fourth New Tanker Delivered

The *S. S. Flying A Washington*, a $6 million, 16,000-ton tanker, was delivered by Bethlehem Sparrows Point Shipyard to the marine fleet operated by Tide Water Associated Oil Co. December 3. The tanker is the second to be delivered by Bethlehem to Tide Water Associated and was the fourth new tanker added to the company fleet this year. The vessel will be capable of handling simultaneously seven different types of liquid oil products through independent systems, and will be equipped to discharge 23,000 barrels per hour. Cruising radius of the vessel will be 12,000 miles. Service will be in the Pacific.

Plans Second Repressure Plant

Creole Petroleum Corp. is engaged in engineering studies and the development of plans for a second major repressuring plant on Lake Maracaibo. The new project will be about twice as large as Tia Juana No. 1 in the LL 370 reservoir which was inaugurated on January 15. (See WORLD PETROLEUM, April 1954; February 1955).

The new unit is to be built over Reservoir LL 453 which is adjacent to LL 370. Studies begun some years ago have shown the reservoir to be isolated by faults from others in the lake.

The plant will be similar in character to Tia Juana, employing centrifugal compressors driven by gas turbines. Larger units will be required since the new plant will handle about 400 million cubic feet of gas daily as compared with 137 million cubic feet at Tia Juana No. 1. Plant completion is scheduled for 1957.

New Deep Hole Geiger Counter

The Radiac Company, Inc., New York, announces the availability of the new DG-9 drill hole geiger counter, specially engineered to meet the needs of users primarily interested in reliability of performance and stability throughout sub-surface uranium exploration operations.

The DG-9 can be used for radioactive probing to a depth of 1,100 feet. Indication features include an easy-to-read sensitivity meter adjustment to zero, earphones, and a flashing neon light. The circuit is completely tropicalized and offers 900 volts of power using only standard batteries.

Fred Norton

Fred Norton, 62, assistant retail sales manager of the Ohio Oil Co. died in Cleveland, December 26, 1954. Mr. Norton was instrumental in the development of one of the first detergent motor oils while chief engineer in the Ohio Oil Company's lubricating sales department in the mid 30's.

Aviation Spirit Pump
Eminently suitable for handling spirits and other volatile fluids, this Screw Displacement Pump is of the all round clearance design and is capable of working with a high suction lift. The flow is practically pulseless and the unit self priming.
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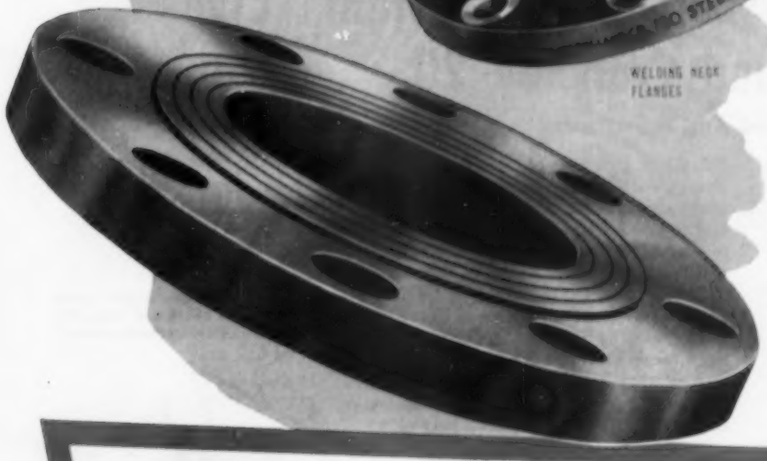
ARABIA

TEXAS

SEEN AROUND RIGS ALL OVER THE WORLD

SLIP ON FLANGES

WELDING NECK FLANGES



MEXICO

CANADA

IRAN

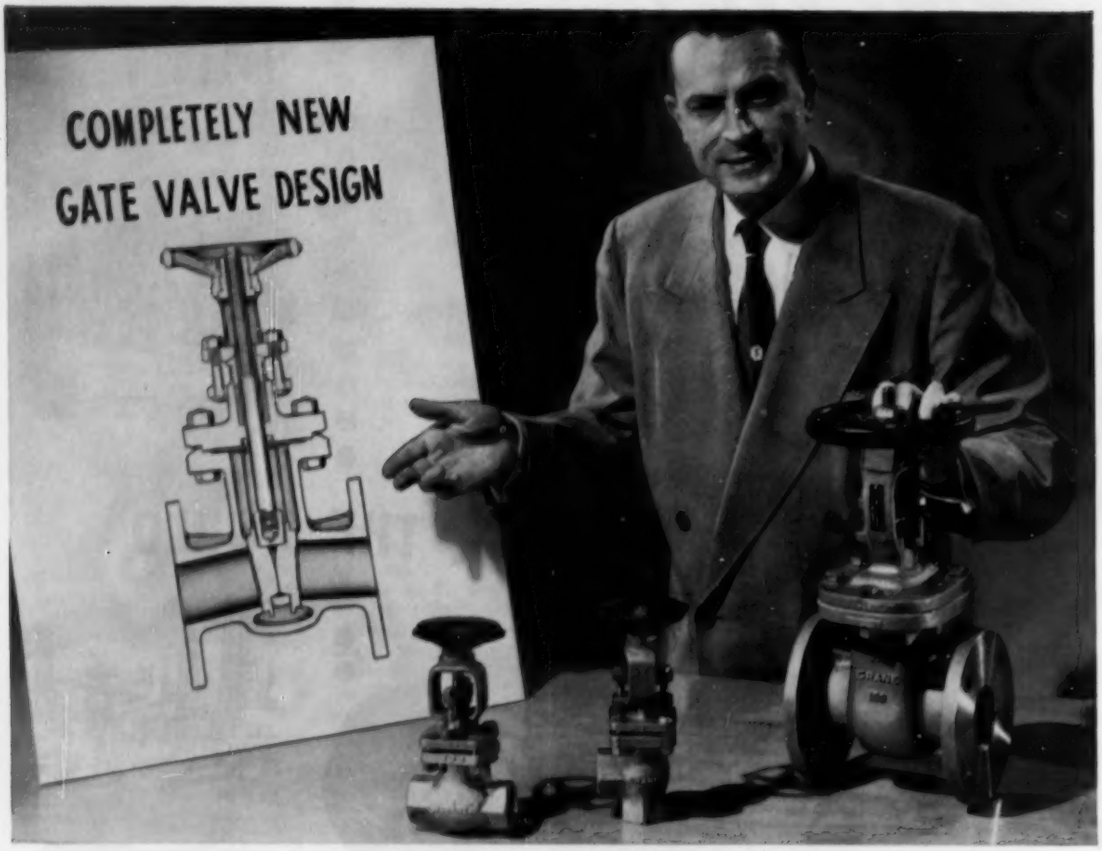
SOLID FORGED WELDLESS STEEL

HIGH PRESSURE FLANGES

BURTON DELINGPOLE & CO. LTD., OLD HILL, STAFFS, ENGLAND

London Office: Whitt & Chambers Ltd., 6 Lygon Place, S.W.1

Telephone: SLOane 7294/5



New CRANE Corrosion-Resistant Valves in 18-8 SMo and Craneloy 20

Gate, Globe and Angle Patterns

Few valves for process industries have ever received the quality treatment given this new Crane line.

Note, for instance, the unique yet simple split-wedge disc construction in the gate valves. Those dual identical discs are free to rotate in their holder—the most effective design for resisting galling. The trunnion shape at the back of each disc assures even distribution of closing forces. You couldn't buckle them if you tried.

The globe and angle valves give equally outstanding control of corrosive fluids. A new type disc-stem connection, with minimum clearances, practically eliminates vibration. By placing seating load closer to seats, it provides easier, more accurate closure.

Throughout, these valves are built for better service in your choice of Crane 18-8 SMo Stainless Steel or Craneloy 20. Both lines come with screwed or flanged ends. Full information given in circular AD 2059—available from your Crane Representative or on request to address below.

New split-wedge disc in gate valves combines the benefits of free rotation with uniform seat load pressure.

CRANE CO.

General Offices:
Crane Co.,
836 S. Michigan Ave.
Chicago 5, Illinois, U.S.A.

In Great Britain:
Crane Ltd.,
45-51 Leman St.
London, E.1, England

In Canada:
Crane Limited,
1170 Beaver Hall Square,
Montreal, Quebec

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

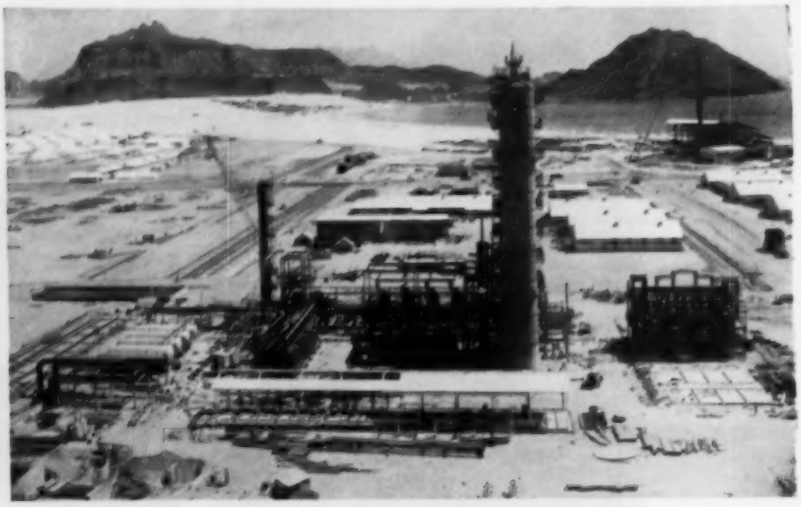
CRANE'S FIRST CENTURY . . . 1855-1955

Offshore Exploration Group, an organization devoted entirely to marine exploration, offers you specialized equipment and interpretation. For example: Specialized cameras automatically record the date, time and location of every shot on each record. The remarkable Reynolds cross-section plotter may be utilized to aid and speed interpretation. With basic patents in the United States, Mexico and Canada, you can expect many improvements leading to more accurate, speedier, less costly seismic surveys from . . .

OFFSHORE EXPLORATION GROUP

3625 Westheimer Road Houston 6, Texas LYnchburg 4851

FISHER
equipment at the Aden Refinery



Photograph by courtesy of Anglo-Iranian Oil Co. Ltd., showing the new 100,000 bbl. per day refinery at Aden under construction.

MORE THAN 330 FISHER CONTROL VALVES, 50 FISHER LEVEL-TROLS AND ANCILLARY FISHER EQUIPMENT

Fisher instruments are installed on the following Units: Platformer, Crude Stills, Solutizer Treating Units, SO_2 Treating Units, Autofiner, Inhibitor & T.E.L. Blending, $CuCl_2$ Treating Units, Steam and Electric Power Plant, Salt Water System, Chemical Handling and Storage and Miscellaneous Services.

FISHER present the most versatile and comprehensive range of Pressure Regulators, Diaphragm Motor Valves and Level Control Equipment for the Petroleum Industry, built to specific requirements to meet the most rigorous pressure, temperature and corrosion service conditions. Catalogue FG2/GB, describing the range of FISHER products, is available upon request.

FISHER WIZARD

Pneumatically operated pressure regulator installed on control valve. The instrument is simple in construction, rugged and accurate.

FISHER LEVEL-TROL

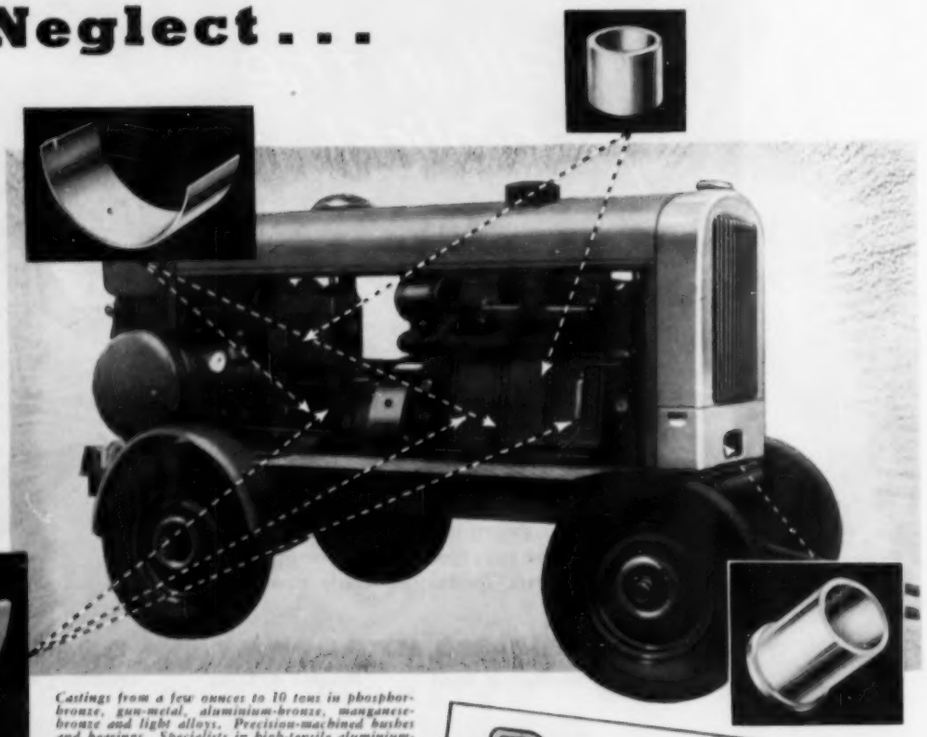
High in sensitivity and accuracy. Handles all varieties of liquids. Ruggedly built, easy to operate and simple to maintain.

MADE IN ENGLAND BY FISHER GOVERNOR CO. LTD., CENTURY WORKS, LONDON, S.E.13 (TIDEWAY 3232)

Used to Neglect . . .

This twin cylinder diesel compressor set will have to work at full pressure for long periods, under arduous conditions and with very little attention. The accuracy and strength of BIRSO non-ferrous castings are relied on to give unfailing service, year in, year out. Illustrated are some of the BIRSO phosphor-bronze castings used in the set, ranging from main bearing shells to connecting rod and starting-handle bushes. They are all cast to the same exacting specifications and precision-machined in our own extensive machine shops.

Our great experience and unrivalled resources, coupled with a *personal* service are available to help solve *your* problems, too.



Castings from a few ounces to 10 tons in phosphor-bronze, gun-metal, aluminium-bronze, manganese-bronze and light alloys. Precision-machined bushes and bearings. Specialists in high-tensile aluminium-bronze castings, centrifugal-cast wheel blanks, and chill-cast rods and tubes.

BIRSO TRADE MARK BN

T. M. BIRKETT, BILLINGTON & NEWTON

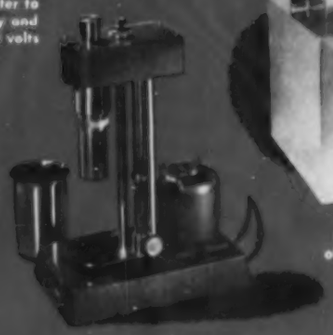
Head Office: HANLEY, STOKE-ON-TRENT • Phone: Stoke 22184
LONGPORT FOUNDRY • Phone: Stoke 87303

One of Britain's Largest* NON-FERROUS *Foundries

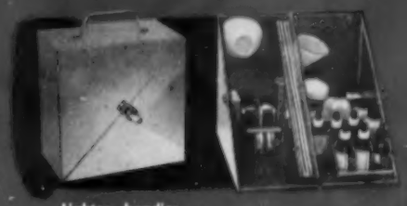
USE THIS *New* BAROID EQUIPMENT FOR FAST, ACCURATE TESTS OF YOUR DRILLING MUDS

Retort kit to test oil, water and solids content of drilling mud

Fann V-G Meter to test viscosity and gels; 6 or 110 volts



Baroid Roller Oven to simulate well conditions of temperature and agitation



Lighter, handier cases for chloride, alkalinity, and water hardness test kits

New equipment . . . improved cabinets . . . better performance! When it comes to mud testing, you won't find equipment easier to use, lighter in weight, or more accurate than Baroid's. Conforms to all API specifications for testing mud density, viscosity, filtration, pH, or other mud properties. Write today for complete data on Baroid equipment.

New portable pH meter: the smallest size yet!

New Filtrate Analysis and Pilot Testing Kit

BAROID DIVISION, NATIONAL LEAD CO.
Equipment Dept., P. O. Box 1675
Houston 1, Texas

Send data on items checked:

- pH Meters and Papers ☐
- Roller Ovens ☐
- Aging Cells and Ovens ☐
- Pilot Testing Kit ☐
- Mud Balances ☐
- Stainless Steel Case for Mud Balances ☐
- Viscometers, Baroid and Fann ☐
- Filter Presses ☐
- Waterproof Stopwatches ☐
- Filtratesters ☐
- Sand Content Kits of Metal and Polyethylene ☐
- Oil and Water Retort ☐
- Portable Mixers ☐
- Chloride Test Kit ☐
- Alkalinity Test Kit ☐
- Water Hardness Kit ☐
- Filtrate Test Kit ☐
- Polyethylene Reagent Bottles ☐

Name_____ Title_____

Company_____

Address_____

City_____ Zone_____ State_____

BAROID

EQUIPMENT DEPARTMENT

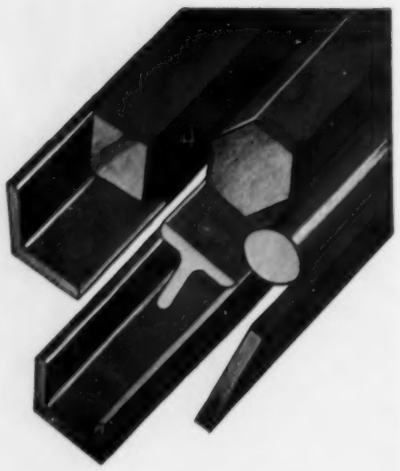
BAROID DIVISION • NATIONAL LEAD CO.

Main Office: P. O. Box 1675, Houston 1, Texas

5050

BARNES & BELL LTD.

79, St. GEORGE'S PLACE, GLASGOW, C.2.



Phone: CITY 7911 (5 lines)
Cables: Barbell - Glasgow
Codes A.B.C. (5th and 6th Ed.) Bentley (2nd)

ALSO AT

COATBRIDGE & BIRMINGHAM

Stockholders & Exporters of:—

NEW IRON and STEEL BARS, SECTIONS and PLATES, BOLTS, TOOLS, NAILS, etc.

•

SLEEPERS and RAILS of all kinds STEEL ARCHES and CORRUGATED STRAPS or BANK BARS for TUNNEL WORK and COLLIERY USE.

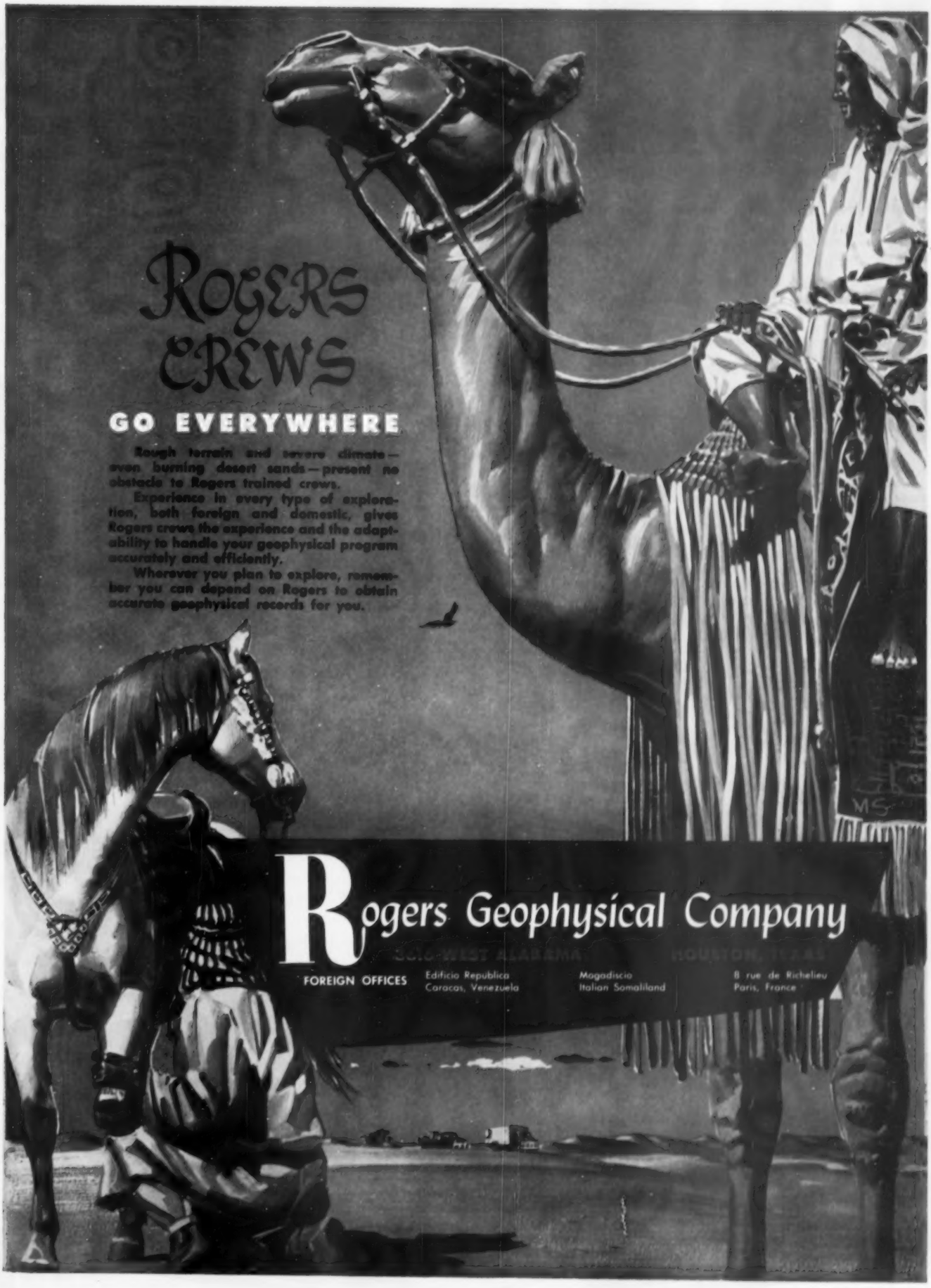
•

BUYING AGENTS

•

Mining Supplies of all Descriptions

•


ROGERS CREWS
GO EVERYWHERE
Rough terrain and severe climate—even burning desert sands—present no obstacle to Rogers trained crews.
Experience in every type of exploration, both foreign and domestic, gives Rogers crews the experience and the adaptability to handle your geophysical program accurately and efficiently.
Wherever you plan to explore, remember you can depend on Rogers to obtain accurate geophysical records for you.
Rogers Geophysical Company
HOUSTON, TEXAS
FOREIGN OFFICES
Edificio Republica
Caracas, Venezuela
Mogadiscio
Italian Somaliland
8 rue de Richelieu
Paris, France

W. W. Goode

G. J. Decker

Harry True

D. W. Cowart

J. A. Mullinax

Schlumberger Personnel Changes

Schlumberger Well Surveying Corp. has announced a number of personnel transfers and promotions in both field and headquarters operations staffs.

W. W. Goode, former assistant area manager for the mid-continent area at Tulsa, has been appointed Permian Basin division manager at Midland, Texas. He replaces George J. Decker, who has been transferred to the office of South Louisiana division manager at Gretna, La.

Harry True has been transferred from Gretna to Tulsa to serve as assistant area manager. In the southeast area, P. P. Favier has been named assistant to the area manager at New Orleans, replacing A. H. Curran, who has been transferred to Canadian operations as manager of the Western Canada division.

D. W. Cowart has been named technical assistant to the vice president, operations department, in the Houston headquarters organization. Mr. Cowart comes to Houston from Edmonton, Alberta where he was manager of the Western Canada division.

J. A. Mullinax has been appointed assistant to the sales manager in Houston and will work on the corporation's advertising program. Before coming to Houston Mr. Mullinax was location manager at Farmington, N.M.

Opens New Headquarters

J. F. Pritchard & Co. held open house for Kansas City and out of town guests December 3 in its new general office structure at 4625 Roanoke Parkway. Incorporating approximately 46,000 square feet of floor space, the building contains executive offices, drafting room, conference room, library and private offices. The building houses 300 employees. Air conditioning and acoustical treatment is used throughout.

J. F. Pritchard & Co. operations now extend from coast to coast, and include many foreign countries.

California Research Plans $1.5 Million Expansion

Construction of more than $1,500,000 in new facilities has been undertaken at the Richmond (Calif.) laboratories of California Research Corp. Involved in the program will be erection of a new engine laboratory and a new wing on the main laboratory-administration building.

Appointed Ethyl General Counsel

Frederick P. Warne has been appointed general counsel of Ethyl Corp. He succeeds William R. Perdue, who was recently elected vice president and treasurer. Mr. Warne has been engaged in the practice of law in New York City.

Petroleum Industry Radio Use Increases

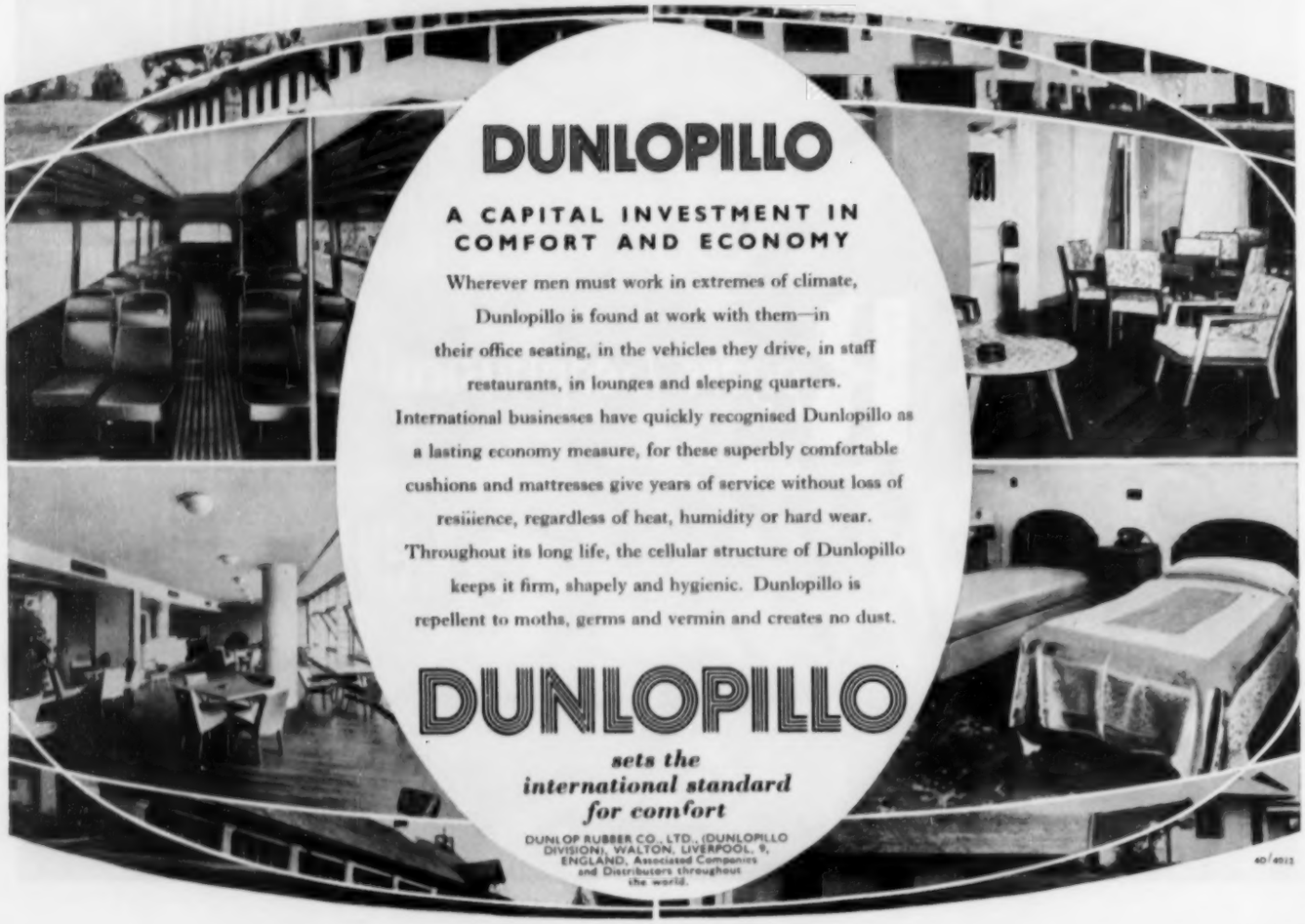
Petroleum industry use of radio and radar in 1954 increased 15.2 percent for a total of 33,587 transmitters used by some 609 users, according to a report of the National Petroleum Council's committee on the use of radio and radar. The report shows that an increasing number of new users are smaller operators, indicating a broadening application through recognition of the efficiency gained through use of radio facilities. Copies of the complete report may be had on request to the National Petroleum Council, 1625 K Street, N.W., Washington 6, D.C.

Seismograph Service Appointees

R. W. Mossman and R. B. Baum have been elected assistant vice presidents of Seismograph Service Corp. Mr. Mossman will be in charge of the northern division of the company's domestic exploration program and Mr. Baum will head the southern unit. The election followed the January 1 resignation of H. M. Thralls as head of SSC's domestic exploration. Mr. Thralls will continue with the company as a director.

R. W. Mossman

R. B. Baum


DUNLOPILLO
A CAPITAL INVESTMENT IN COMFORT AND ECONOMY
Wherever men must work in extremes of climate, Dunlopillo is found at work with them—in their office seating, in the vehicles they drive, in staff restaurants, in lounges and sleeping quarters. International businesses have quickly recognised Dunlopillo as a lasting economy measure, for these superbly comfortable cushions and mattresses give years of service without loss of resilience, regardless of heat, humidity or hard wear. Throughout its long life, the cellular structure of Dunlopillo keeps it firm, shapely and hygienic. Dunlopillo is repellent to moths, germs and vermin and creates no dust.
DUNLOPILLO
sets the international standard for comfort
DUNLOP RUBBER CO., LTD., (DUNLOPILLO DIVISION), WALTON, LIVERPOOL, 9, ENGLAND, Associated Companies and Distributors throughout the world.

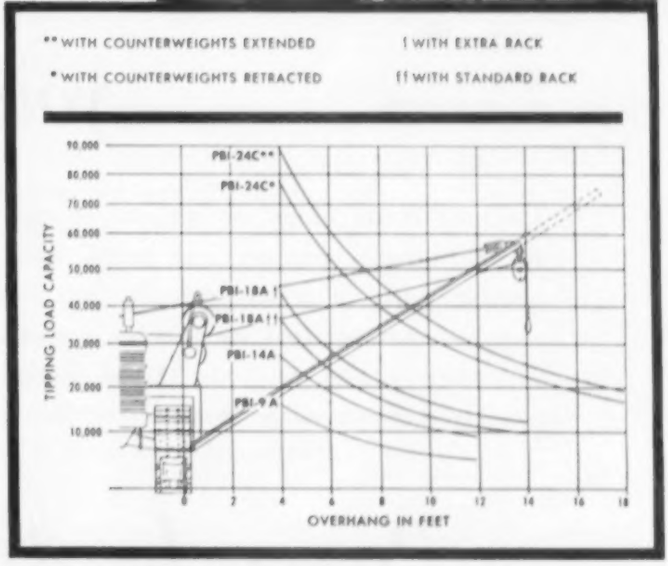
Champion weight lifters!

INTERNATIONAL SUPERIOR Crawler Pipeboom Combinations

On big inch or feeder lines . . . these job-proved International Superior tractor-pipeboom units provide pipeliners with the latest in working efficiency, safety, and ease of operation.

With lifting capacities of up to 90,000 lbs., these units are fast in transporting pipe and lowering-in . . . slow for lifting and holding . . . and maneuverable at all speeds in the tight spots. The superior balance and ample ground clearance give an operating advantage on stringing, stabbing, doping or wrapping. Boom and load lines are positively controlled . . . no dropping the load.

See your IH distributor for complete details on the International Superior Crawler Pipeboom best suited to *your* job, or write for free Catalog CR-420-D.



A size for every job! Whether your pipeline project is a small water line or a giant big-inch gas line, an International tractor and matched Superior pipeboom can do it better. The chart above shows the range of capacities...from the husky PBI-9A to the weight-lifting champion PBI-24C.

Power That Pays

INTERNATIONAL INDUSTRIAL POWER

INTERNATIONAL HARVESTER EXPORT COMPANY, 180 N. MICHIGAN AVE., CHICAGO 1, ILL., U.S.A.

4-cylinder Power Mule incorporating the 4DJ420 Diesel Engine developing 66 B.H.P. at 1600 R.P.M. on a continuous rating.

you will find . . .

Meadows Power Mules are designed to meet the need for a compact and easily transportable source of power. Sturdily built and completely self-contained, the units are available with either a 4 or 6-cylinder Diesel Engine covering a power range from 40-150 B.H.P. Units are also available for operation on natural gas.

Meadows Power Mules provide trouble-free service in undeveloped areas and can claim a well established reputation of reliability under diverse climatic conditions.

Power by MEADOWS

HENRY MEADOWS LIMITED

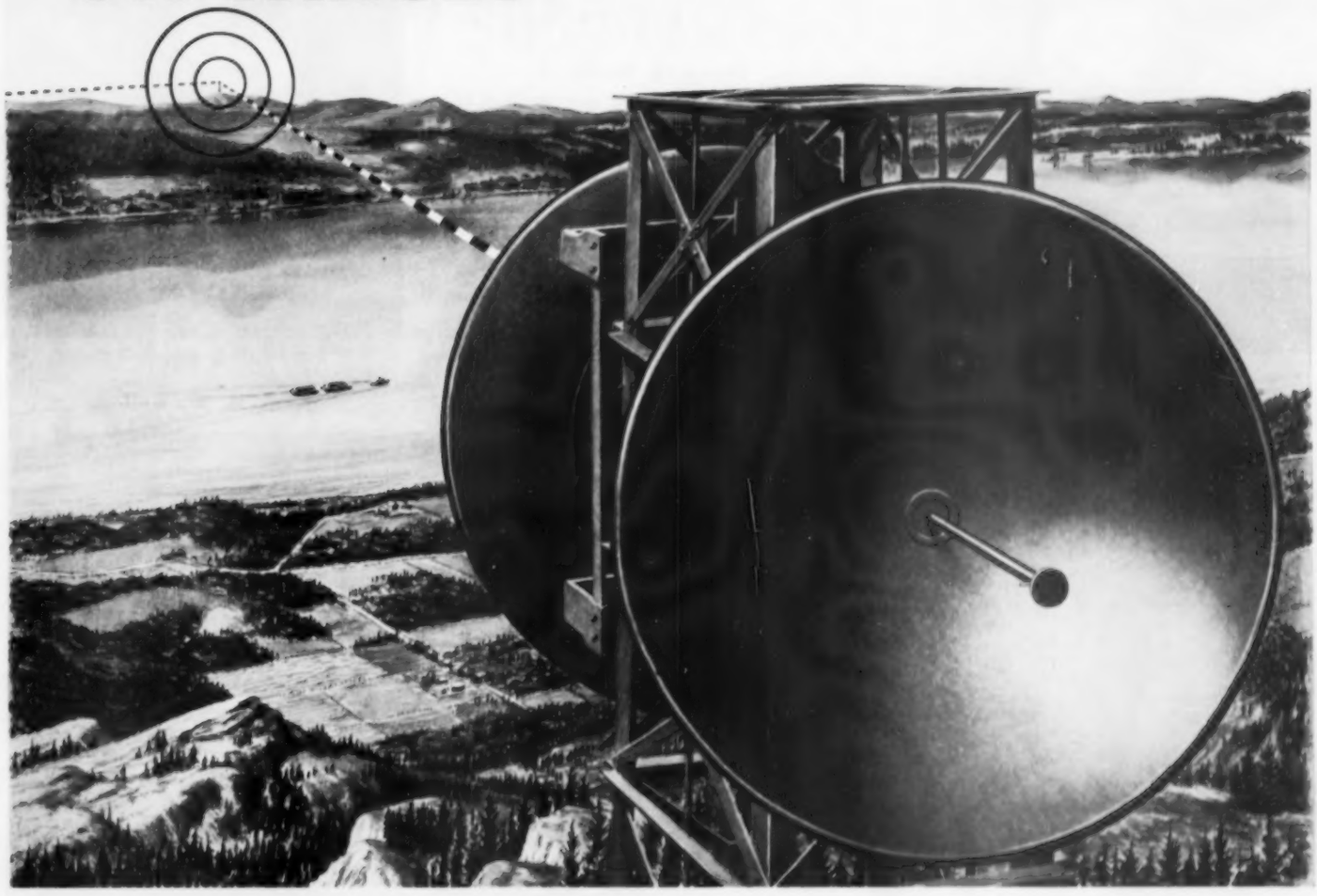
INDUSTRIAL DIVISION

FALLINGS PARK, WOLVERHAMPTON, ENGLAND

Telephone : Wolverhampton 31921 Telegrams and Cables : OUTPUT Wolverhampton

AN ASSOCIATED BRITISH ENGINEERING COMPANY

"ON TARGET"



. . . FOR ALL-INCLUSIVE, ALL-WEATHER COMMUNICATIONS THROUGH MICROWAVE

Microwave goes straight to the core of communications problems—with a simple solution! No costly wireline construction or maintenance . . . dish-like antennas beam the microwave signal between line-of-sight points separated by waterways, jungles, forests, or mountainous areas. Transmission is completely reliable, for it is *unaffected by weather*. Simultaneous, multi-channel operation easily accommodates the volume and variety of communications so vital to modern business. For example, as many as 19 telegraph circuits can be carried by any *one* of the many telephone channels provided by the ISE system.

Microwave was successfully demonstrated for the first time in 1931 by International Telephone and Telegraph Corporation. Today this system, developed and improved through the years, is made available outside the United States through ISE, associate of IT&T. Would you like the facts on what microwave can mean to *your* communications? ISE engineers will be happy to consult with you.

International Standard Electric Corporation

ISE — An IT&T Associate

Export Department, 50 Church St., New York 7, N. Y., U. S. A.

Central telephone exchange equipment for installations of any size, automatic or manual.

Cables, wires, conduits, structures—equipment and supplies for every communication and power need.

Radio aids to air navigation . . . complete airport communications and lighting systems.

Teleprinters for automatic transmission and reception of written messages.

All equipment for television and radio broadcasting and receiving . . . point-to-point communication.

T. P. Brown

Scientific Design Appoints Vice President

The appointment of Thomas P. Brown as vice president of Scientific Design Company, Inc., New York, has been announced. The firm specializes in the design and engineering of organic chemical processes and plants. Mr. Brown was formerly technical vice president of Reichhold Chemicals, Inc., where he served for 15 years. He has been placed in charge of new project developments for Scientific Design.

Other changes at Scientific Design included the promotion of Henry F. Peters to assistant vice president of the engineering department, David Brown to assistant vice president of the development department, Paul S. Monroe to director of engineering and Dr. Robert S. Barker to assistant director of research.

Drilling Mud Compound

Monsanto Chemical Co. has introduced Filcon SPF, a new mud additive which is said to reduce drilling time. It is especially recommended for drilling salt and anhydride sections.

Harry O. Heller

Harry O. Heller, 64, former vice president of Southwestern Engraving Co. and for the past 20 years advertising manager of Reed Roller Bit Co., died December 1, at his home in Houston.

A native of Ft. Wayne, Indiana, Mr. Heller moved to Houston soon after his discharge from the 4th Division Infantry, World War I, where he saw front-line service in the many famous battles in which this division distinguished itself in France.

Mr. Heller received his basic education at Ft. Wayne, Indiana, and his art education at Chicago. He was the second president of the Houston chapter of the National Industrial Advertisers Association, and always took a leading part in the activities of this and other advertising and marketing organizations.

Edward L. Wagon

Edward L. Wagon, assistant vice president of Sinclair Oil Corp., died January 14 at his home in Tuckahoe, New York. He was 63 years of age.

Mr. Wagon was born in Oldham, England and trained there as an accountant. He came to this country in 1914 with Price, Waterhouse & Co. and in 1916 joined the Sinclair Oil & Refining Corp. when that company was first organized.

After serving in the Tulsa, Okla. office as an accountant during the company's formative years, Mr. Wagon was transferred to New York as assistant general auditor in 1920. He held various executive posts with the Sinclair organization during his 28 years of service.

W. G. Alexson

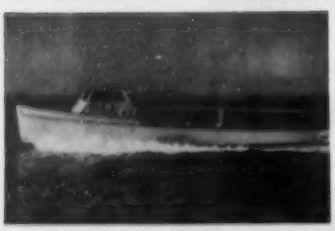
Joins M. W. Kellogg

Wallace G. Alexson has joined the staff of the contract sales department of The M. W. Kellogg Co. A chemical engineer, Mr. Alexson most recently was in charge of crude evaluation work for the Esso Standard Oil Co., with which company he was associated for nine years and was also on loan to the government for two years serving in an administrative capacity with the Office of Rubber Reserves in Washington, coordinating the butadiene feed-stock program.

Timken District Manager

D. G. Gibson has been appointed district manager of The Timken Roller Bearing Company's Dallas territory, succeeding the late Harry Trump. He was formerly assistant district manager.

BOATS for



OFFSHORE DRILLING

Fire Boats
Tug Boats
Personnel Boats
Barges
Work Boats

WOOD OR STEEL

Complete maintenance and repair facilities including 1,000 ton dry dock

Boat Builders since 1896

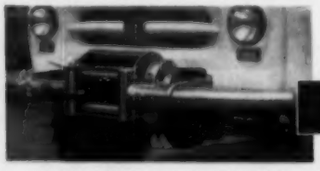
FELLOWS and STEWART, Inc.
TERMINAL ISLAND, CALIFORNIA

Koenig ALL-STEEL JEEP CABS

FULL AND HALF CABS

Koenig All-Steel Cabs Have These Superior Features:

- Protection—Complete protection in all kinds of weather . . . valuable cargo protected by locks.
- Safety—All-steel, welded construction. No rivets . . . safety glass throughout.
- Comfort—Full panel-board head lining and masonite door lining . . . no vibration.
- Convenience—Roll-down windows, full opening.



KING WINCHES

KING WINCHES FOR KING-SIZE PULLING JOBS

For all Willys Jeeps, trucks and 4 x 4 station wagons . . . also for Ford, Chevrolet, International and Dodge trucks.

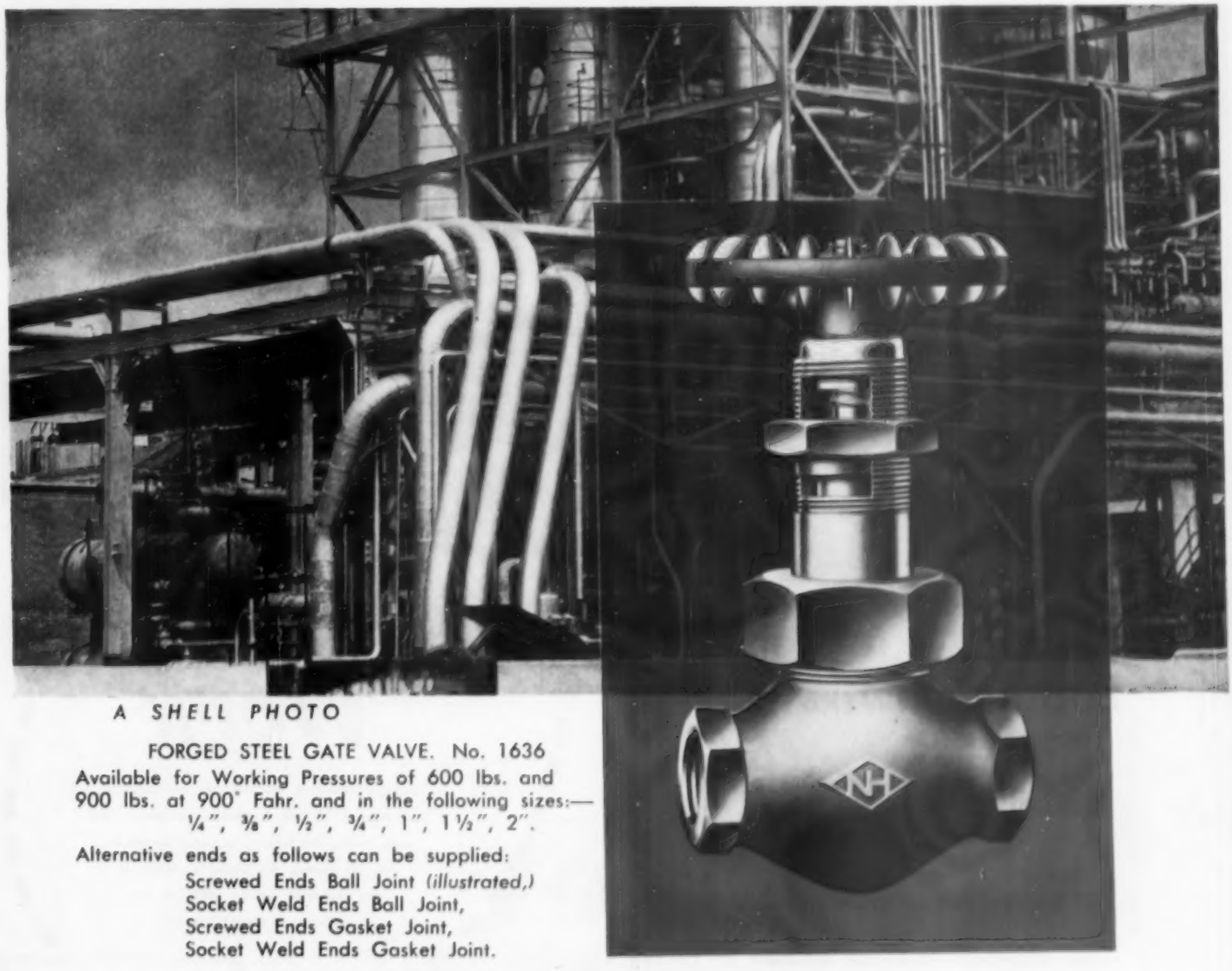
King Winches keep you moving through the most difficult terrain . . . you get action where there's no traction with dependable pull power designed to fit specific pull and hoist needs. Koenig power winches have pull capacities of 8,000 to 19,000 lbs.

Koenig Jeep cabs and King Winches for Willys vehicles are available through Kaiser-Willys distributors and dealers . . . write for free descriptive literature.

Koenig IRON WORKS, Inc.
2214 Washington Ave. Houston, Texas

Regularly supplied to the PETROLEUM INDUSTRY

NEWMAN-HENDER *valves*



A SHELL PHOTO

FORGED STEEL GATE VALVE. No. 1636
Available for Working Pressures of 600 lbs. and 900 lbs. at 900° Fahr. and in the following sizes:—
¼", ⅜", ½", ¾", 1", 1½", 2".

Alternative ends as follows can be supplied:
Screwed Ends Ball Joint *(illustrated,)*
Socket Weld Ends Ball Joint,
Screwed Ends Gasket Joint,
Socket Weld Ends Gasket Joint.

Newman, Hender & Co. Ltd
WOODCHESTER GLOS. ENGLAND

BROTHERHOOD
STEAM TURBINES

FOR DRIVING PUMPS, ETC.

Wide range — All types.
Over 40 years' experience.
Hundreds in hand — thousands in service.

BROTHERHOOD
COMPRESSORS

Air, Gas and Refrigerating.
The widest range in the British Empire — made to suit your requirements.
Thousands in service.

BROTHERHOOD
GENERATING SETS

Turbine driven up to 11,000 KW.
Engine driven up to 340 KW.
Hundreds in hand.

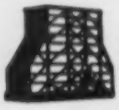
BROTHERHOOD
REFRIGERATING PLANT

Ammonia, CO_2, Freon, Methyl Chloride, SO_2. Wide range — single and double acting — one or more stages.

BROTHERHOOD
STEAM ENGINES

High Speed Vertical
up to 500 B.H.P.
Over one hundred in hand.

BROTHERHOOD
COOLING TOWERS



All types.
Nearly 50 years' experience.

also Manufacturers of all kinds of

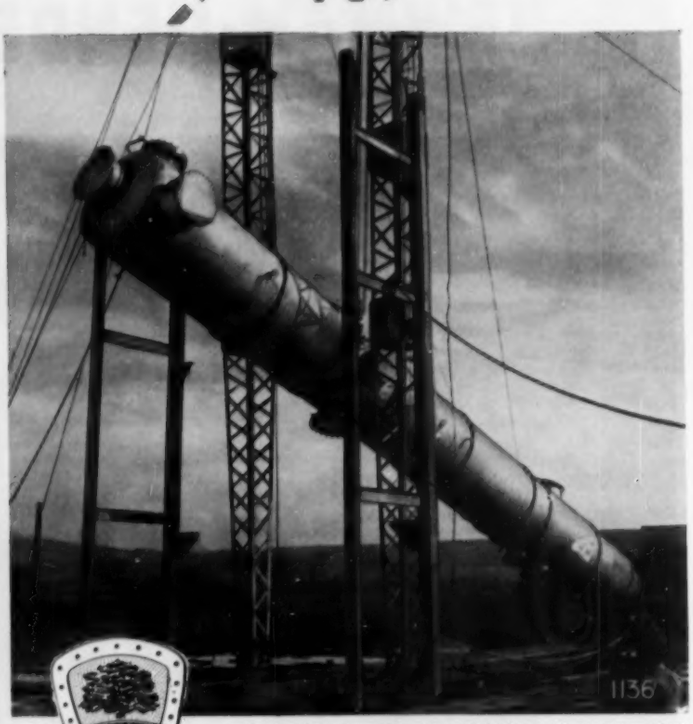
PLANT TO CUSTOMERS' OWN DESIGNS

WHY NOT SEND YOUR PROBLEMS TO US?

We shall be pleased to investigate them confidentially without commitment

PETER BROTHERHOOD LTD
PETERBOROUGH ENGLAND
SPECIALISTS IN COMPRESSOR PLANT SPECIALISTS FOR NEARLY A CENTURY

Jenkins
of ROTHERHAM
for



Fractionating column 6'-9" dia. x 69'-0" high made for Foster Wheeler Ltd. for Hess Products Ltd. : Fatty Acid Plant.

IVANHOE TRADE MARK

Welded Work

The Ivanhoe trademark identifies the craftsmanship and dependability of Jenkins-welded equipment. Pipe work, tanks, fractionating columns, condensers, pressure vessels, are typical examples of the fabricated welded work we are producing to Class I standard.

Our new catalogue "Welded Fabrications" details our organisation and facilities. May we send you a copy?

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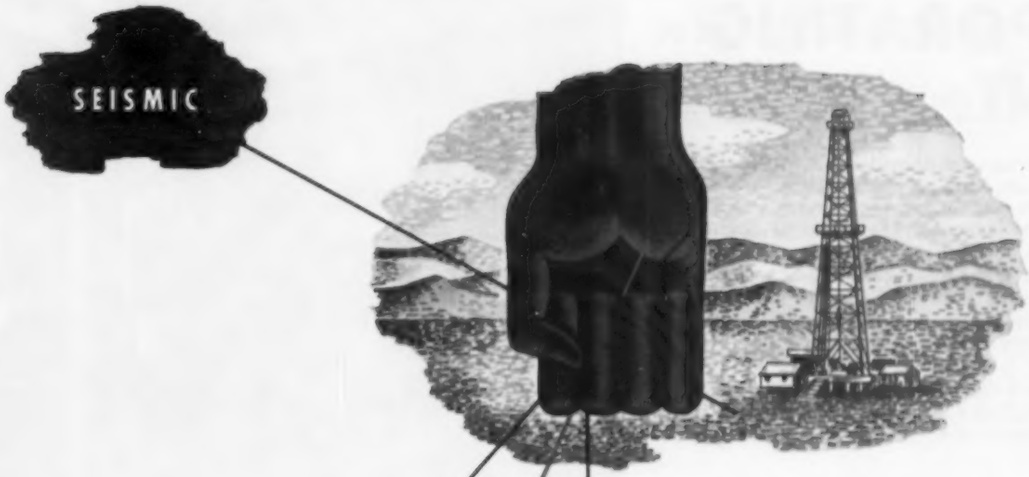

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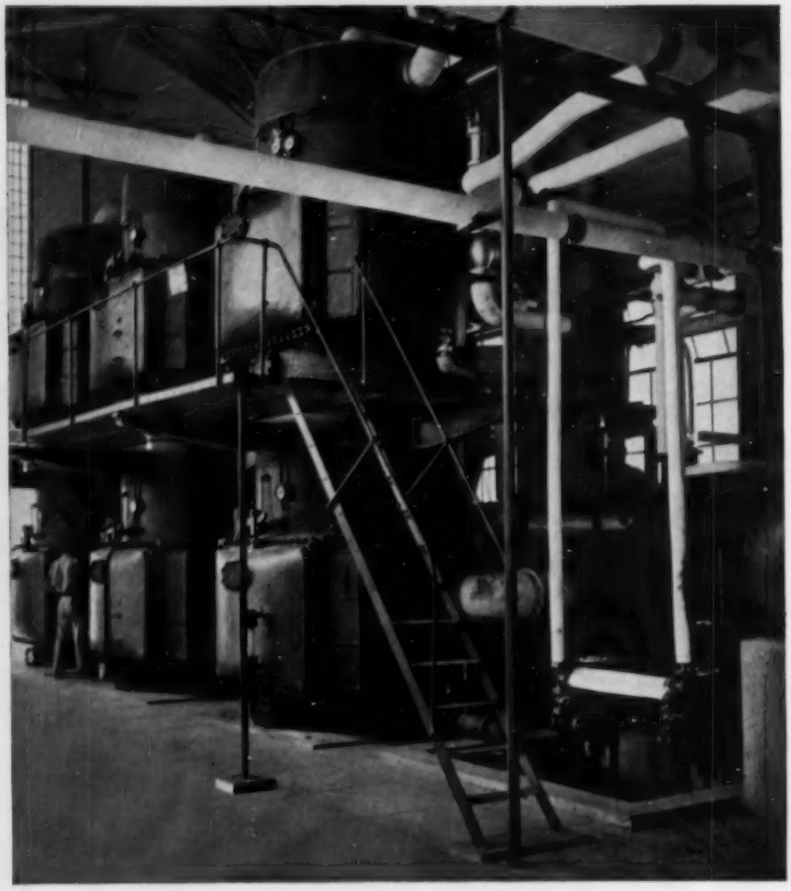

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The Tubend range of welding fittings meet the requirements of practically every type of prefabricated pipe assembly and the facility, economy and efficiency of fabrication becomes even more marked when working in confined spaces and effecting difficult directional changes.

The Tubend range comprises: elbows, return bends, reducers, tees and caps manufactured under strict supervision to meet the requirements of both British and American specifications.

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What one tube steel will give you the best life/cost ratio? *Ask the experts!*

This month's report is on: **DM STEEL**

Has unusually high creep strength for a pearlitic steel, good stability up to 1200° F., fairly good corrosion and oxidation resistance. Has 2 to 3 times the life of carbon steel where corrosion is not severe. Recommended for cracking furnace tubes, hot oil lines, superheater tubes, high temperature steam piping and forgings for accessory parts.

ONE OF 24 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 5S	18-8 Ti
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	16-13-3
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-20*
Silmo	Sicromo 3	Sicromo 9M	25-12*
DM	4-6% Cr.-Mo.	18-8 Stainless	35-15**
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	16-25-6**

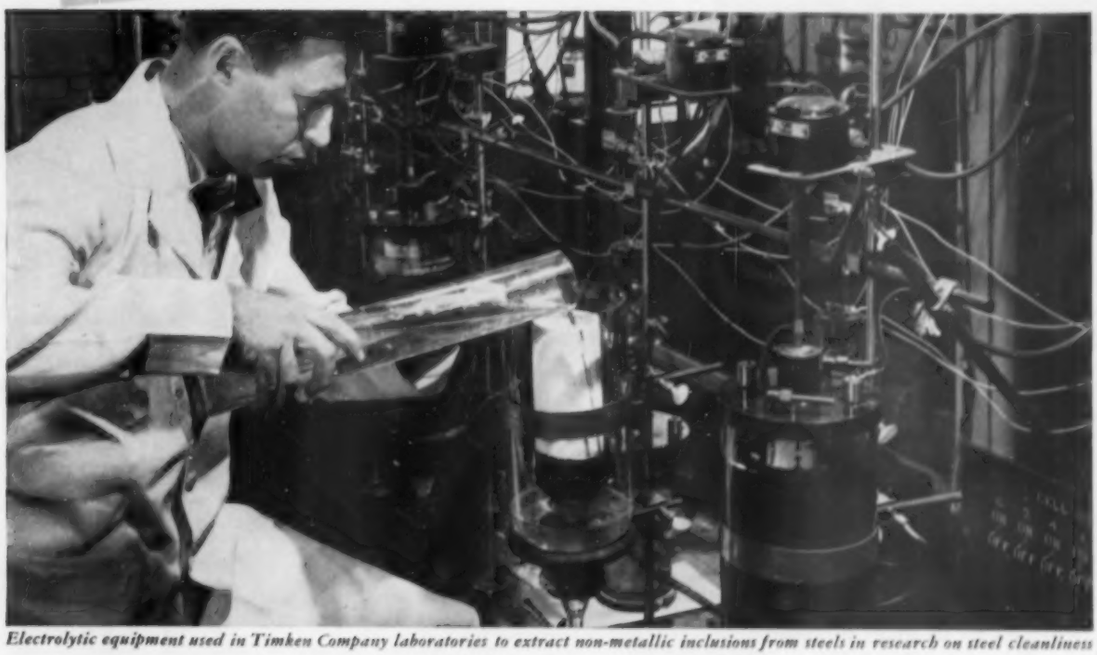
**Available as seamless tubing on an experimental basis only.*
***Not available as seamless tubing.*

THERE are probably several high temperature tube steels that will solve your heat, pressure, corrosion and oxidation problems. But there's only one analysis that will give you maximum tube life per dollar.

To find it, *ask the experts!*

With over 20 years of steel research and experience, Timken Company metallurgists are recognized authorities on high temperature steels. They'll use this experience to help you select from 24 different analyses, pick the one tube steel that will give you the best life/cost ratio. And regardless which analysis you select, you'll be assured of uniform quality because the Timken Company rigidly controls quality from melt shop through final inspection.

Let the Timken Company's RSQ—Research, Supply, Quality—solve your tube problems. *Ask the experts!* The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



Electrolytic equipment used in Timken Company laboratories to extract non-metallic inclusions from steels in research on steel cleanliness

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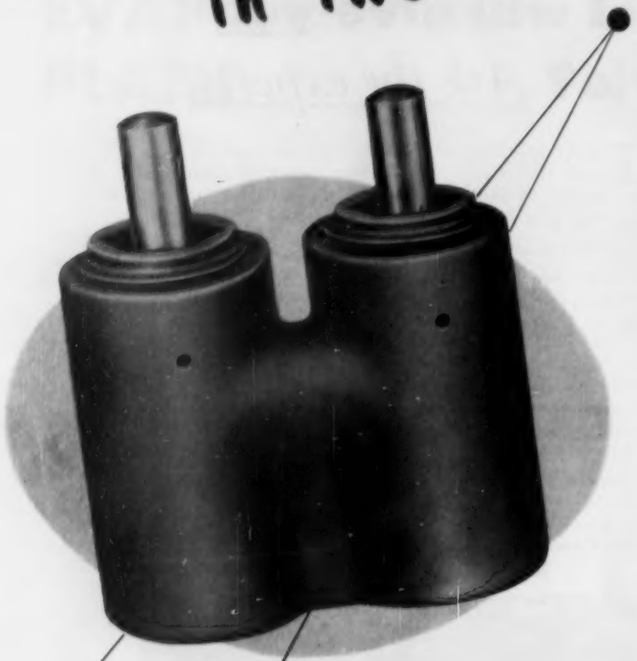

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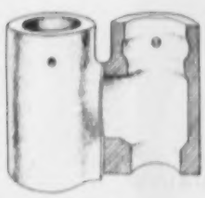
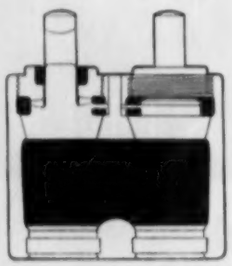
Osborn-Ohio Return Bends for Refineries and Chemical Plant, are designed to take full advantage of the principle of Directional Solidification. For the user this means castings that give better service over a longer period.

Type 1640 is recognised for its ability to withstand higher temperatures and pressure, and in common with all types of Osborn-Ohio fittings, can be depended upon to give first rate performance.

TYPE 1640



For strength at high pressure and temperatures. Detailed recommendations for particular conditions will gladly be given.



Catalogues upon request.

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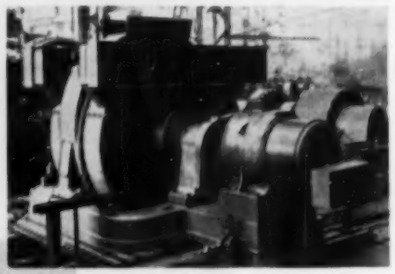
Electric motors breathe too . . . and these VOKES filters have proved conspicuously successful in preventing the grave damage hitherto sustained during operations in impure air conditions.



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Compressors . . . portable generators . . . welding sets . . . power packs . . . all need protection against the ingress of abrasive dust, whether by air-intake, lubricating oil or fuel.

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Under abnormal conditions like these, engines have to be doubly protected and these large diesel engines are therefore fitted with Microvee dry fabric filters for cleaning the intake air. Vokes Filters are also specified for atmospheric air filtration in the ventilating systems of many of the desert buildings.

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As fact after fact is analyzed, more and more oil companies are impressed with Furfural refining and the wisdom of scheduling it for future adoption. Over 40 oil companies have already been impressed to the point of adopting Furfural for its basic benefits: Yield, *high*—Quality, *high*—Cost, *low*.

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HIGHLY SELECTIVE for sharp and rapid phase separation.

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W. A. Meiter

Heads Worthington Sales

William A. Meiter, central sales manager of Worthington Corp., has been promoted general sales manager. He succeeds Thomas J. Kehane, who has been appointed vice president in charge of sales.

Standard Oil Development Appointments

Six new deputy coordinators have been appointed by Standard Oil Development Co. to assist six vice presidents. Men named are: F. L. Miller, D. L. Campbell, W. F. Persons, C. E. Paules, R. M. Shepardson and A. D. Green.

Dr. Miller will be deputy to W. C. Asbury for patents, contracts, legal matters and public relations; Mr. Campbell, deputy to E. J. Gohr for research and development work on fuel processes and analytical research; Mr. Persons, deputy to Dr. A. P. Hewlett for general administration; Mr. Paules, deputy to E. W. Luster for engineering; Mr. Shepardson, deputy to Dr. W. J. Sweeney for petroleum products and medical research; and Mr. Green, deputy to Dr. C. O. Tongberg for chemical research and process research on lubes and specialty products.

Deepest Drill Hole Abandoned

The deepest drill hole ever bored in the earth's surface was definitely abandoned in January after reaching a record depth of 21,482 feet — without oil. The wildcat was drilled by Ohio Oil Co. in the Paloma district of Kern County, Calif. It was spudded in October 23, 1951 and work on it continued with frequent interruptions until the beginning of the present year. The exact cost of the operation has not been published, but it is estimated above $2,000,000.

Harry L. Shoemaker

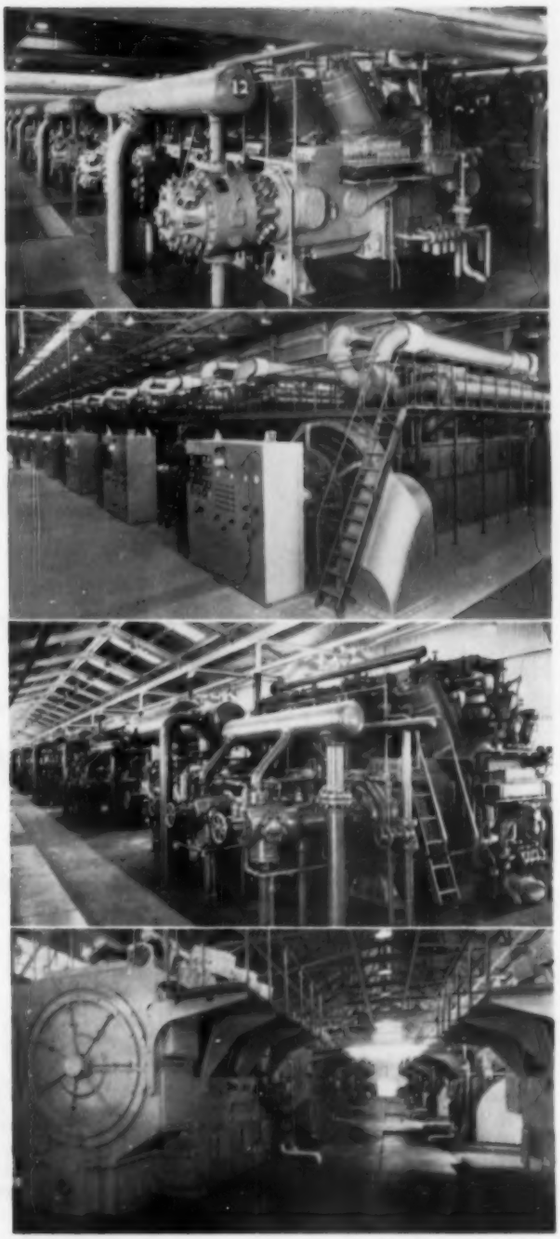
Harry L. Shoemaker, 62, former Standard Oil Co. (N.J.) executive, died December 19 at East Orange, N.J. Mr. Shoemaker was secretary of Jersey Standard's Coordination Committee when he retired in 1953 after 38 years of service with the company and affiliates. He previously had served 12 years in the company's general engineering department, rising to supervisory engineer in charge of planning and construction for Jersey Standard's affiliates throughout the world.

Robert W. Miller

Robert W. Miller, a vice president and director of Creole Petroleum Corp., an affiliate of Standard Oil Co. (N.J.) died December 10 while on a business trip in London, England.

Mr. Miller was first employed by the Standard Oil Co. (N.J.) in January 1919 as clerk in the Bayway refinery. He was appointed export sales manager of the Creole Petroleum Corp. in 1944, elected a vice president in September 1947, and a director in May 1948.

THE TRUTH
about pipeline power today!



OVER $200,000,000 worth of Cooper-Bessemer gas engine driven compressors are pumping gas today.

This totals more than 4,000 units, on over *forty* of the country's largest gas transmission lines.

Hundreds of these units have been in continuous operation not for just one year, not five years, but many for over *forty* years!

Cooper-Bessemer reciprocating compressors have been improved every year since 1910 . . . fuel consumption lowered, reliability improved, availability bettered and maintenance costs reduced. That's why every year sees more Cooper-Bessemers installed to serve the expanding gas line industry!

All this *because* . . .

1. A gas transmission company is its own biggest customer . . . and these modern gas engine units operate on 25 to 35% less fuel than a direct fired gas turbine.

2. Nothing equals experience! The efficiency, reliability and economy of Cooper-Bessemer reciprocating compressors is the reason why gas companies who use them *continue* to use them.

3. The total installed cost of a reciprocating compressor is just as low as that of a direct fired gas turbine.

4. Maintenance cost on a gas pipe line is not measured by the experience of the first year, or by the second year, but over the full life of the project. There are hundreds of records to prove you just can't beat the long-range maintenance economy of Cooper-Bessemers.

If it's your money going into a new gas pipe line project, or any other heavy-duty power application for that matter, you'll be wise to ask if Cooper-Bessemer engines or compressors are to furnish the power.

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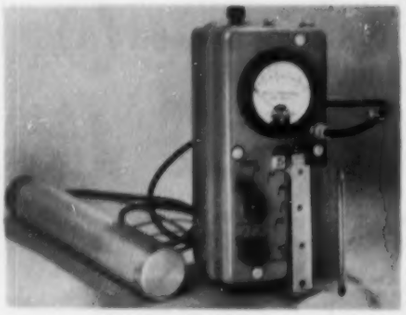

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Membership in the club is limited specifically to men who have served in an executive capacity for at least 25 years with Los Angeles and Orange County firms engaged in the manufacturing or processing of metals. Most of the members have been oil industry equipment manufacturers. The club motto is Fellowship and there are no assessments, no dues, and no formalities. Currently there are over 120 members in the organization.

Directors of the Quarter Century Metals Club include: Delbert Axelson, retired, Axelson Manufacturing Co.; William Batchelor, general manager, General Electric Co., Ontario; W. A. DeRidder, retired, General Metals Corp.; W. W. Farrar, vice president, Farbest Corp.; Robert Gregg, foundry manager, Reliance Regulator Division, American Meter Co.; Jim Griffin, president, James H. Griffin Co.; Earle V. Grover, president, Apex Steel Corp. Ltd.; Ott Hammer, president, Security Engineering Division, Dresser Operations, Inc., Earle M. Jorgensen, president, Earle M. Jorgensen Co.; Lloyd D. Kay, president, Kay-Brunner Steel Products, Inc.; J. C. Meyer, general partner, Snyder Foundry Supply Co.; K. T. Norris, president, Norris-Thermador Corp.; Morris B. Pendleton, president, Plomb Tool Co.; John B. Raue, chairman of the board, United States Spring & Bumper Co.; Alden G. Rocah, president, Columbia-Geneva Steel Division, U. S. Steel Corp.; Lionel J. Soracco, manager of sales, Bethlehem Pacific Coast Steel Corp.; J. D. Spalding, works manager, The National Supply Co.; R. A. Stumm, president, Southern Pipe and Casing Co.; Reese H. Taylor, president, Union Oil Company of California; and C. B. Tibbetts, president, L. A. Steel Casting Co.

Dr. G. M. Lees

Dr. G. M. Lees, who served for many years as chief geologist of Anglo-Iranian Oil Co. and was a recognized geological authority on the Middle East, died in a London hospital on January 25 at the age of 56.

After passing through the military academy at Woolwich, young Lees joined the forces during the first World War and was sent to Mesopotamia where he won the Distinguished Flying Cross. After the war he served temporarily as assistant political officer in southern Kurdistan. While there he became interested in the geology of the district and this led him to join the then Anglo Persian Oil Co. as assistant geologist in 1921.

For the next nine years Dr. Lees took part in many important surveys, including those on Haft Kel, Gach Saran, Agha Jari and Pazanum. During this time he was instrumental in obtaining an option from the Shaikh of Qatar on exploratory rights in his territory and spent a year on study leave at the University of Vienna where he obtained a Ph.D. degree.

In 1932, at the age of 32, Dr. Lees was appointed chief geologist of Anglo-Iranian and in succeeding years he traveled extensively not only in the Middle East, but also in other oil provinces. He discovered oil sands on the Dorset coast which led to the search for oil in Britain.

Dr. Lees received many honors in recognition of his work. In 1943 he was awarded the medal of the Geological Society for his work in Persia, Oman and England. In 1948 he was elected a Fellow of the Royal Society and he served as president of the Geological Society for two years. Because of ill health, he resigned his post with Anglo-Iranian in 1951, but continued the association in an advisory capacity.

Continuous Automatic Blender

Proportioneers, Inc., Providence, R.I., has developed a two-component blender for "on stream" blending. It is recommended for caustic dilution, asphalt blending, cutting of heavy fuel oil and blending of butane and gasoline.

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By Walter H. Voskuil

Chief Mineral Economist, Ill. State Geol. Survey; Prof. of Mineral Economics, Coll. of Engr. Univ. of Illinois.
224 pp., 24 maps, 37 tables, $5.75

In simple, non-technical language this book describes the part played by minerals in economic productivity and in building and maintaining a high standard of living. Throughout it emphasizes the role of minerals in developing a distinctive American culture.

Step by step the book takes you from the functions of minerals in industry through the interests of the United States in the distribution and extent of the world's mineral resources. It treats in detail the particular contribution of each mineral to our productive economy. Included are iron, ferroalloys, coal, oil, gas, nonferrous metals, mineral plant foods, and sulfur.

The discussion includes a comprehensive treatment of the ramifications of America's mineral industry in world affairs.

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Lease Pumping Booklet

"Reliable Lease-Pump Power" is the title of a new booklet depicting the use of Caterpillar diesel engines and electric sets used in lease pumping. The booklet stresses dependability and economy of operation, whether Caterpillar diesel engines are used for prime movers, secondary recovery or for single or multiple electrified or mechanical pumping units.

Photographs of actual pumping sites are contained in the booklet showing Cat engines to be all-weather, round-the-clock performers. The back cover of the book places emphasis on the swift Cat dealer parts service facilities whether or not an oil site is "close to civilization."

The booklet, Form D479, may be ordered from Caterpillar Tractor Co., Peoria, Ill., or from any Caterpillar dealer.

New Automatic Transmission Fluid

The development of a new and improved type of automatic transmission fluid, known as Trojan Hydrafluid A.T.F. Type A, has been announced by Cities Service Research and Development Co. According to W. W. Scheumann, vice president and general manager, this new A.T.F. has extremely low pour characteristics, exceptionally high oxidation stability, high detergency, excellent anti-foaming characteristics and low carbon residue. Five years of laboratory and field test work went into the development of the product.

Davison District Sales Manager

Davison Chemical Co., division of W. R. Grace & Co., has appointed Charles E. Meginnis district sales manager, industrial chemicals department, with headquarters at 19 S. LaSalle Street, Chicago, Ill. Mr. Meginnis has been resident field service engineer at this address since July 1953.

Dr. G. K. Teal

Heads Texas Instruments Research

Dr. Gordon K. Teal, assistant vice president of Texas Instruments Inc., has been appointed to head the research division of the Dallas-based electronics and geophysics firm. Dr. Teal has directed the materials and components research department of Texas Instruments during the past two years.

Uranium Exploration

Uranium exploration activities in the Colorado plateau area and other mineralized regions of western United States are being undertaken by The New Jersey Zinc Co. and The Texas Co. Should a uranium discovery be made with sufficient deposits to justify mining, a separate company may be formed.

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Combustion Gas Turbines

General Electric Company's combustion gas turbines for power generation and mechanical drive are described in a revised bulletin designated GEA-5516B. Gas turbine-steam turbine cycles, mechanical drive applications, design features, control and governing, generators, tables of characteristics, and dimensions and weights are among subjects covered. Requests for the bulletin should be addressed to the General Electric Co., Schenectady 5, New York.

New Service Office

McCullough Tool Co. has opened a new service location at 32 Front Street, Rio Vista, Calif. The new branch is under the supervision of K. A. Summers, a veteran McCullough employee.

New Officers for GSI

Frederick E. Romberg has been appointed manager of the gravity division of Geophysical Service, Inc., Dallas, and Dr. Richard A. Geyer has been named chief geophysicist. Prior to joining the division, Dr. Geyer had served as research geophysicist for the Humble Oil & Refining Co. since 1945. Mr. Romberg was formerly manager of the Dallas-based firm's southern division in Houston and will maintain headquarters there.

Ray H. Wright replaces Mr. Romberg as manager of the company's southern division.

Corrosion Resistant Coating Developed

Vitreco, Inc., a research company jointly owned by Poor & Co., Chicago, and Youngstown Sheet & Tube Co., Youngstown, Ohio, has developed a new line of inorganic silicate coatings for fusing to ferrous metals at temperatures from 900° to 1,200°F. The new finishes are corrosion resistant and can be applied to ferrous metals at low firing temperatures. The company is engaged in extensive field testing of bolted and welded sour crude storage tanks in the mid-continent field. The steel tanks, protected inside and out with a thin film of Porcenell, have required practically no maintenance since installation.

NPC Appoints Tank Truck Study Committee

Walter S. Hallanan, chairman of the National Petroleum Council, has announced the appointment of a committee to study the problem of over-the-road transportation (tank truck) in a possible emergency.

An estimate will be made of the maximum increase of carrying capacity of the tank truck fleet and of the number and capacity of semi-trailer tanks that could be used in over-the-road service.

Graver Offers Technical Reprints on Oil Removal

Technical reprint T-124, which discusses oil removal from water and methods of de-oiling refinery waste water, is now available from Graver Water Conditioning Co., 216 West 14th Street, New York 11, New York.

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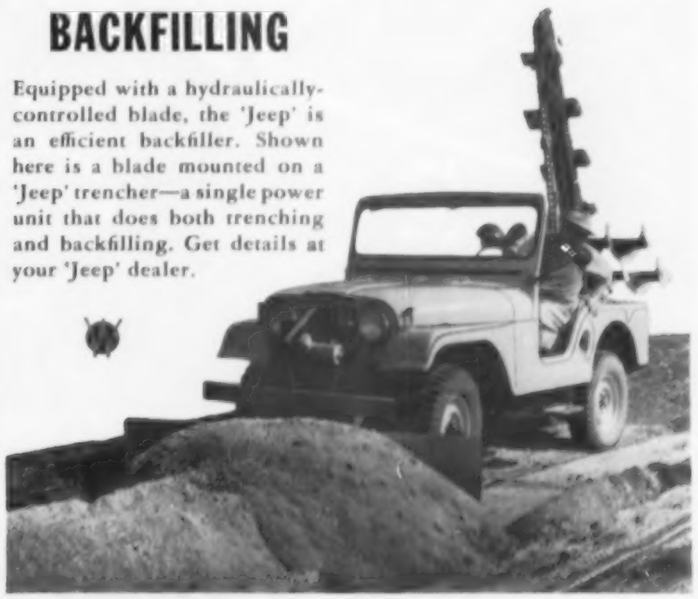

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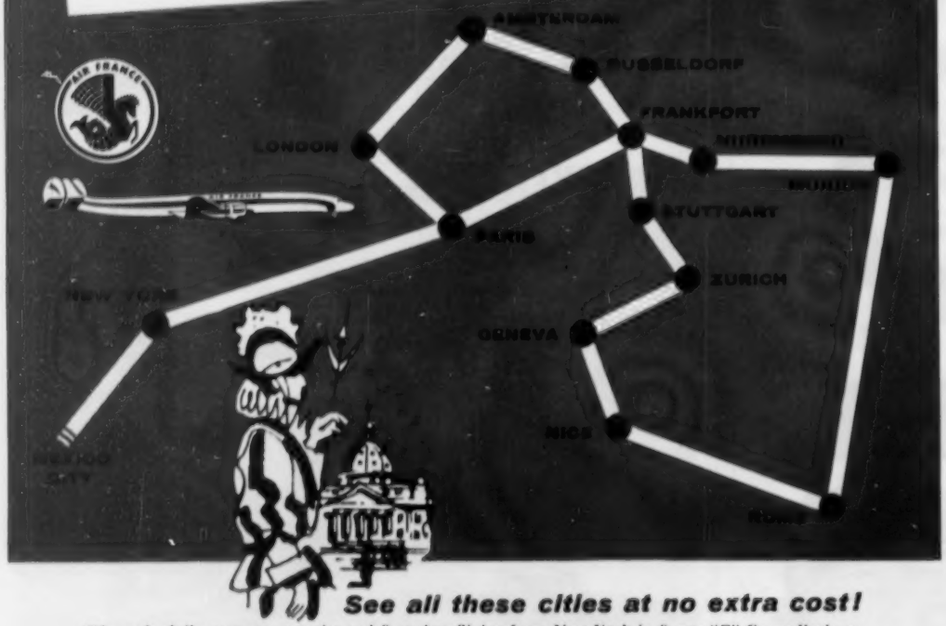

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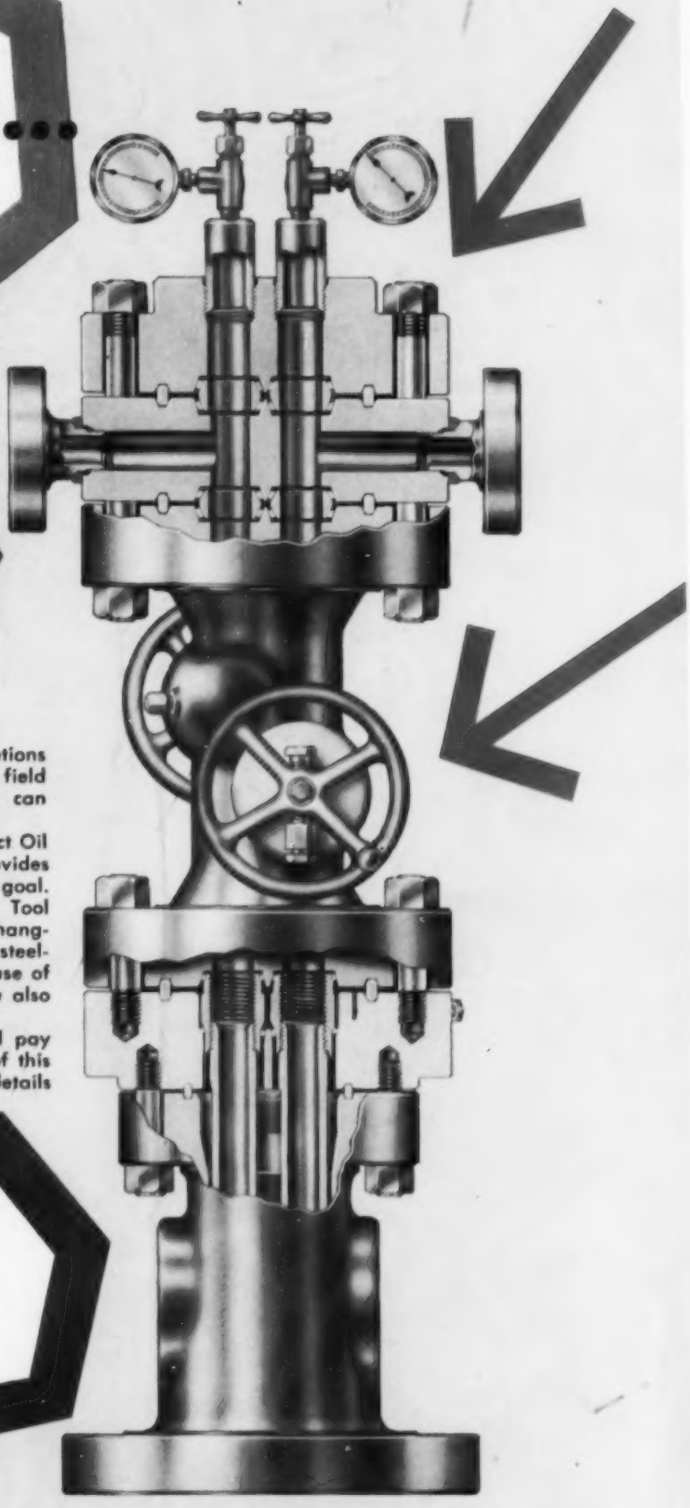

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